MODULE

TEACHING OF PHYSICS

CLASSES XI-XII

FOR

MASTER TRAINERS/TEACHERS

(In-Service Teacher Training Programme)

DIRECTORATE OF CURRICULUM AND TEACHER EDUCATION NWFP ABBOTTABAD

FEBRUARY, 2003

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Title	**Module Teaching of Physics for Classes XI- XII for Master Trainers/Teachers of In-service Training Programme**
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FOREWORD

Directorate of Curriculum & Teacher Education, NWFP, Abbottabad is launching a comprehensive programme of in-service teachers training through out the province for all subjects/categories for the classes 6th to 12th under the title "Teacher Training Programme" scheme Improvement of Learning Environment For Quality Improvement for the year 2002-2004 as per policy of the Govt of NWFP, School & Literacy Department, Peshawar. The prime focus of this manual is training delivery effectively. There are two approaches to teacher's professional development, the carport approach and the individual one, but in this guide book attempts are made to link the both practically.

To make the INSET Programme more effective and successful a "Survey Study" has been conducted to collect the feed back, needs of the learners, requirements of the teaching staff and desires of the concerned managers through, interview/questionnaires, survey form and classroom observation forms. Sample for the study was selected a few middle and secondary/Higher Secondary schools (Girls boys urban & rural).

The study was conducted by the Deputy Director (Training) and Subject Specialists of this Directorate.

In the light of above information & facts training strategy and instructional material has been developed to improve the learning environment for quality improvement through the innovative methodology and pedagogical techniques.

Instructional material consists on training manual for lead trainers & field trainers for delivery of training effectively and modules for all subjects for the classes VI–XII in Science/Arts to facilitate the field Trainers as well as trainees of all categories (SS, SET (Science/Arts), CT, AT, TT).

The training manual comprises two parts, one for Subject Specialists training imparted by PITE and the other one for SET/CT/AT/TT training imparted by RITEs NWFP.

Umar Farooq
Director
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NWFP, Abbottabad

Module of Physics for XI & XII

Rationale of Module

Physics is a branch of science based upon the reasons & logic. One cannot learn Physics only by memorizing the contents and knowledge of the material but can learn by the practical involvement and application of content & knowledge.

The course of the Physics for Class XI & XII is based upon various chapters and concept out of which there are some areas chapters that are considered to by difficult for the students as well as for the teachers.

In this module an attempt is made not only to identify the difficult & hard areas of the course but also an attempt is made to solve & explain that hard areas in a very simple and practical language, so that it becomes very simple, easy, meaningful and stimulated for the students as well as for the teachers.

In this module, not only the contents of the course are explained, but also for the help of the teacher, the special attention is given to the methodology of the content, objectives of the content, required material to teach the content, and procedure to achieve the objectives of the content. The self-assessment questions are also included at the end of each content methodology, which helps the students as well as the teachers for effective learning.

For the explanation of content very simple and daily useable examples are given and related numerical problems are solved for the guidance of students.

The good point of this module is that an increasing knowledge about all the contents has been added for the help of teachers.

The hard areas of the course enclosed in this module are:

1. Multiplication of Vectors
2. Variation of 'g'
3. Momentum
4. Capacitors
5. Ampere's Law
6. A.C. Generator
7. Modern Physics and
8. Atomic Spectra

In multiplication of vectors, all the components of vector product, scalar product, and the characteristics of scalar and vector product are given in detail. In the variation of 'g' it is explained that 'g' is constant on the surface of earth and it decreases as the body moves upward through heights 'h' and decreases when the body goes inside the earth to a depth 'h'. In momentum, the definition, the change, the conservation and elastic and inelastic collision and collision of different bodies moving with different velocities are explained.

In the concept of capacitor, the definition, construction, function, capacitance as well as the kinds of the capacitors along with the uses and application are included.
In A.C. generator more attention is given to explain the phenomena of rotation of the coil and the production of alternating induced emf. The mathematical equation of A.C. voltage is also explained & proved in this module.

The Ampere's Law is assumed to be difficult, so it is explained and its application is also explained in a very simple manner. Similarly, the concepts of modern Physics and atomic spectra are explained in very detail.

Despite of best efforts, some errors and deficiencies are expected to be in the module. The readers are requested to point these errors and deficiencies and inform the Directorate of Curriculum & Teacher Education NWFP Abbottabad for improvement and modifications.

Lesson No. 1

Concept: MOMENTUM

Objectives of the Concept

The objectives of the concept are to know about the:

1. Momentum of the moving bodies
2. The Change of the momentum of the moving bodies
3. The laws of the conservation of momentum
4. Elastic & inelastic collision of moving bodies
5. Collision of moving bodies of different masses moving with different velocities

MOMENTUM

***Required Material*:** Chalk, Duster. Black Board, Marbles, Solid Ball and Rubber Ball

Content:

If a body of mass 'm' is moving with a velocity 'v' then the product of its mass & velocity is called momentum. It is mathematically written as:

$p = mv$ ______________ (1)

When the body is moving horizontally on the surface of earth, its velocity is linear & the momentum is called linear momentum. It is Physical quantity & can be measured in SI system of units, the unit of momentum is:

$p = \text{Kg-m/sec}$

Or $p = \text{Kg-m/sec} \times \text{sec/sec}$

$\Rightarrow \text{Kg-m/sec}^2 \times \text{sec}$

$\Rightarrow \text{N} \times \text{sec}$

It is a vector quantity. It has its direction.

To explain momentum, we can give daily use examples as a comparison of motion of a moving Suzuki and a man on the road. The man's mass is small as well as the man's velocity is less & the velocity as well as the mass of the moving Suzuki is larger thus the momentum of the Suzuki is much greater than the momentum of man. Similarly, when the Suzuki is compared with the bus, the momentum of the bus is greater than the Suzuki. The quantity, which is obtained as a product of mass & velocity of the moving body, is called momentum.

CHANGE OF MOMENTUM

If the body is moving with initial velocity V_i and after interval of the time the velocity changes to V_f then, the momentum (as depend upon the velocity), will also change. It is written as the initial momentum is:

$p_1 = mV_i$ & the final momentum is $p_2 = mV_f$

The change in momentum is $= mV_f - mV_i = \Delta p$

Or $\Delta p = p_1 - p_2$

Change in momentum w.r.t. time is $\Delta p/\Delta t = (mV_f - mV_i)/\Delta t$

This change in momentum w.r.t. time is called 'Force' or mathematically:

$F = \Delta p/\Delta t$

Or $\Delta p = F \times \Delta t$ __________ (ii)

Equation (ii) explain that the rate of change of momentum is always equal to the net force applied upon the body, which is also called 2nd Law of Motion, according to which:

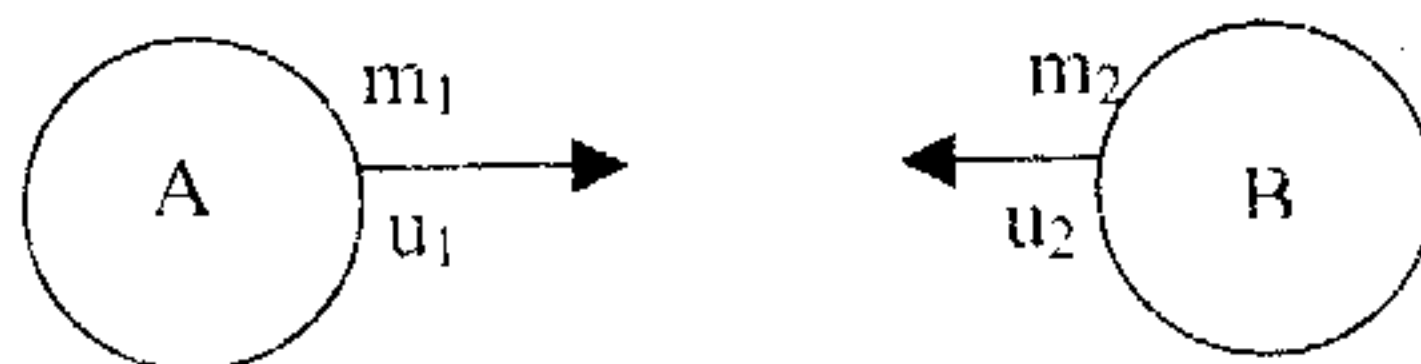
$F = ma$

Or $m(V_f - V_i)/\Delta t = F$ ____________ (iii)

Law of Conservation of Momentum:

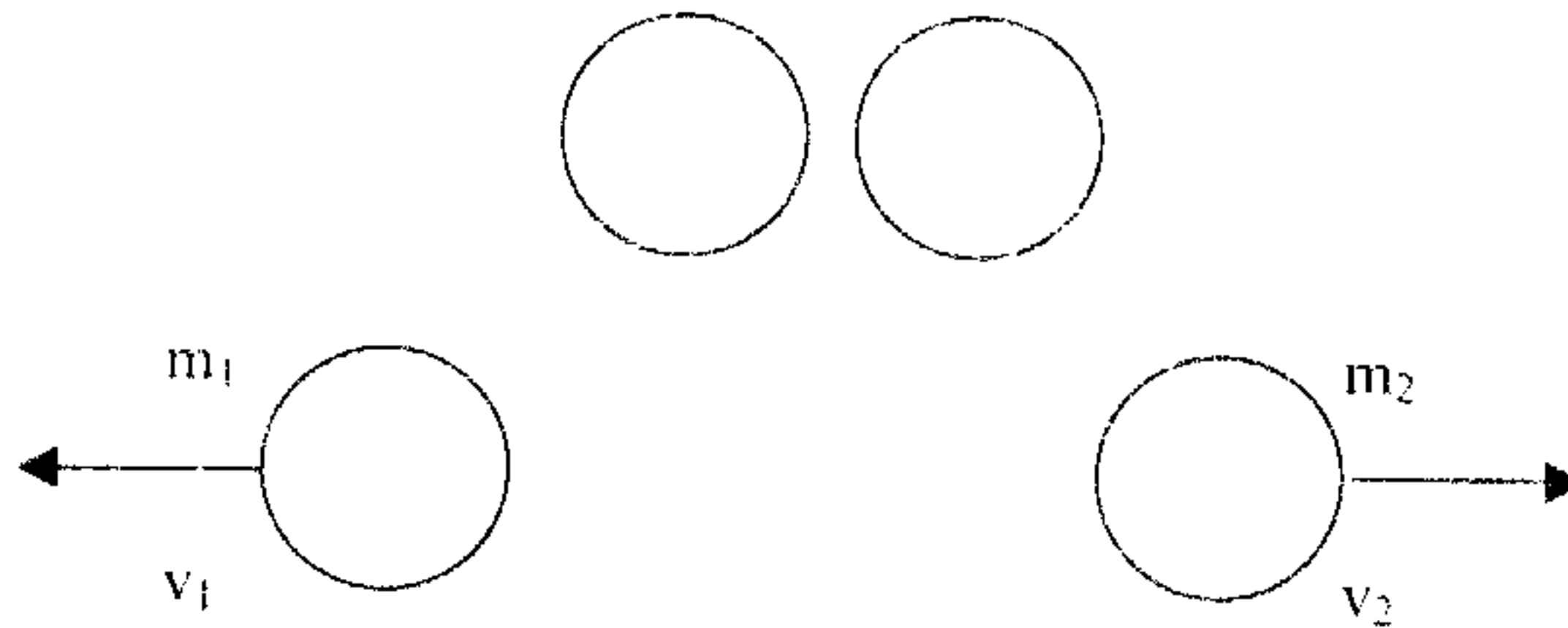
This law states that:

> *"When a system consisting of two bodies moving with different velocities towards each other, collide with each other, the total momentum of the system before collision, remains equal to the total momentum after the collision, either the collision is elastic or inelastic."*

To explain this law we can take very simple of two bodies of mass m_1 and m_2 moving with velocities u_1 & u_2 respectively as shown in given figure:

The momentum of the 1st body before collision $= m_1u_1$

The momentum of the 2nd body before collision $= m_2u_2$

Total momentum before collision $= m_1u_1 + m_2u_2$ ____________ (1)

When the two bodies collide with each other & change their velocity to v_1 & v_2 respectively in opposite directions as shown in given fig:

The momentum of 1st body after collision = m_1v_1

The momentum of 2nd body after collision = m_2v_2

The total momentum after collision = $m_1 v_1 + m_2v_2$ ____________ (2)

According to law of conservation of momentum:

Momentum before the collision = Momentum after the collision

Therefore $m_1u_1 + m_2u_2 = m_1 v_1 + m_2v_2$ ____________________ (3)

ELASTIC COLLISION:

"The collision of two bodies such that their momentum and Kinetic Energy both are conserved is called two bodies Elastic Collision."

To explain this collision we consider two bodies of mass is $m_1 = 2Kg$ & $m_2 = 1Kg$ moving with velocity $u_1 = 2$ m/sec & $u_2 = 0$

The momentum of 1st body = $m_1u_1 = 2 \times 2 = 4$ N-sec

The momentum of 2nd body = $m_2u_2 = 1 \times 0 = 0$

Total momentum = $m_1u_1 + m_2u_2 = 4 + 0 = 4$ N-sec ______________ (1)

The K.E. of 1st body = $\frac{1}{2}(m_1u_1^2) = \frac{1}{2} \times 2 \times 2 \times 2 = 4$

The K.E. of 2nd body = $\frac{1}{2}(m_2u_2^2) = \frac{1}{2} \times 1 \times 0 = 0$

Total K.E. = $\frac{1}{2}(m_1u_1^2) + \frac{1}{2}(m_2u_2^2) = 4 + 0 = 4$ _______________ (2)

After sometime the bodies collide with each other and change their velocities as V_1 & V_2 such that $V_1 = 2/3$ m/sec & $V_2 = 2/3$ m/sec

The momentum of 1st body after collision = $m_1V_1 = 2 \times 2/3 = 4/3$ N-sec

The momentum of 2nd body after collision = $m_2V_2 = 1 \times 8/3 = 8/3$ N-sec

Total momentum after collision $= mV_1 + m_2V_2 = 4/3 + 8/3 = 12/3 = 4$ N-sec ________ (3)

The K.E. of 1st body after collision = $\frac{1}{2}(m_1v_1^2) = \frac{1}{2} \times 2 \times 2/3 \times 2/3 = 4/9$

The K.E. of 2^{nd} body after collision = $\frac{1}{2}(m_2v_2^2) = \frac{1}{2} \times 1 \times 8/3 \times 8/3 = 32/9$

Total K.E. after collision = $4/9 \times 32/9 = 36/9 = 4$ ____________ (4)

Comparing equation (1) and (3) we found that the total momentum before the collision is equal to the total momentum after the collision and comparing equation (2) and (4). Thus it can be said that:

> *"The total K.E. before collision is equal to the total K.E. after the collision".*

Thus we say that the collision is elastic collision.

INELASTIC COLLISION

> *"The collision in which the momentum is conserved & the K.E. is not conserved is called inelastic collision."*

Elastic Collision in One Dimension

> *"Inelastic collision when the bodies are moving on the surface of earth horizontally, it is called One-dimensional elastic collision."*

In one-dimensional elastic collision:

$m_1u_1 + m_2u_2 = m_1 v_1 + m_2v_2$ ____________ (1)

& $\frac{1}{2}(m_1u_1^2) + \frac{1}{2}(m_2u_2^2) = \frac{1}{2}(m_1v_1^2) + \frac{1}{2}(m_2v_2^2)$ ____________ (2)

From equation (1)

$m_1(u_1 - v_1) = m_2(v_2 - u_2)$ ____________ (3)

& From equation (2)

$\frac{1}{2} m_1(u_1^2 - v_1^2) = \frac{1}{2} m_2 (v_2^2 - u_2^2)$

or $m_1(u_1 - v_1)(u_1 + v_1) = m_2(v_2 - u_2)(v_2 + u_2)$ ____________ (4)

Dividing (4) by (3) we have:

$(u_1 + v_1) = (v_2 + u_2)$ ____________ (5)

In equation (5) u_1 & u_2 are known velocities and v_1 & v_2 are unknown. These can be find as:

$v_1 = u_2 + v_2 - u_1$ ____________ (6)

Putting this in equation (1) we have:

$$m_1u_1 + m_2u_2 = m_1(u_2 + v_2 - u_1) + m_2 v_2$$

$$= m_1u_2 + m_1v_2 - m_1u_1 + m_2v_2$$

$$m_1u_1 + m_2u_2 + m_1u_1 = m_1u_2 + m_1v_2 + m_2v_2$$

$2m_1u_1 \quad = m_1u_2 + m_1v_2 + m_2v_2 - m_2u_2$

$= m_1u_2 - m_2u_2 + v_2(m_1 + m_2)$

$= u_2(m_1 - m_2) + v_2(m_1 + m_2)$

Or $\quad v_2(m_1 + m_2) \quad = 2m_1u_1 - (m_1 - m_2)u_2$

$v_2 = 2m_1u_1/(m_1 + m_2) - (m_1 - m_2)u_2/(m_1 + m_2)$ ____________ (7)

Similarly from equation (5)

$v_2 = (u_1 + v_1) - u_2 = u_1 + v_1 - u_2$

Putting this in equation (1) we have:

$m_1u_1 + m_2u_2 \quad = m_1v_1 + m_2(u_1 + v_1 - u_2)$

$= m_1v_1 + m_2u_1 + m_2v_1 - m_2$

$m_1u_1 + m_2u_2 - m_2u_2 \quad = m_1v_1 + m_2u_1 + m_2v_1$

$2m_2u_2 \quad = m_1v_1 + m_2u_1 + m_2v_1 - m_1u_1$

$= (m_1 + m_2)\, v_1 + (m_2 - m_1)\, u_1$

Or $\quad (m_1 + m_2)\, v_1 \quad = 2m_2u_2 - (m_2 - m_1)\, u_1$

Or $\quad v_1 = (m_1 - m_2)\, u_1/(m_1 + m_2) + 2m_2u_2/(m_1 + m_2)$ ____________ (8)

Special Cases

There are some cases of special interest for collision of two bodies:

Case I

When the man of two bodies $m_1 = m_2 = m$ & the velocity u_1, u_2 & v_1, v_2 respectively the $v_1 = u_2$ & $v_2 = u_1$. This shows that after the collision the velocities of the bodies are interchanged.

Case II

When the masses are equal & the 1st body is at rest before collision. i.e. $m_1 = m_2 = m$ & $u_1 = 0$ then $v_1 = u_2$ & $v_2 = 0$ = The 2nd body after collision will come to rest & body will start with velocity u_2.

Case III

When $m_1 >>> m_2$ and the 1st body is moving with velocity u_1 and the 2nd body is at rest such that $u_2 = 0$.

$$V_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) U_1 + \left(\frac{2m_2}{m_1 + m_2}\right) U_2$$

As $m_2 = 0$ (negligibly small then equal to zero)

$v_1 = (m_1 / m_1)\, u_2 + 0 = u_2$

& $$V_2 = \left(\frac{2m_1}{m_1 + m_2}\right) U_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) U_2$$

$\Rightarrow \quad 2\,(m_1 / m_1)\, u_1 + 0 = 2u_1$

$\Rightarrow \quad v_2 = 2u_1$

This show that the 1st body will when collide with the higher body, it will continue its velocity as u_1 and the 2nd body will start moving with a velocity double the velocity of 1st as 2 u_1.

Case VI

When $m_1 <<< m_2$ and 1st body is moving with velocity u_1 and the 2nd body is at rest such that $u_2 = 0$. Then m_1 is negligibly small and is equal to zero. Then putting the values $v_1 = -u_1$ and $v_2 = 0$.

This employs that when a lighter body collide with the heavier body then the lighter body after colliding return back with a same velocity as $v_1 = -u_1$ and the 2nd body at rest.

Methodology

Instruction for teacher

1. Divide the topic into two periods
2. Use mostly the black board
3. Demonstrate the available activities to the students
4. Teach the topic as in given activities

<u>Activity No: 1</u>

1. On entering in the ask the following question from the student:
   - i) Which of the body have heavier mass:
   - a) Robber ball b) Solid ball
   - ii) When both are fallen from same distance, which will damage the surface more and why?
2. Write the topic on the black board as momentum

3 Tell the students that product of the mass and velocity of a moving body called momentum. It is denoted by 'p' and mathematically written as p=mV _____ (1)
It is a physical quantity and its units for measurement in SI system is N-m.

4 Explain the momentum on the black board as well as its unit for measurement by the comparison body of different masses and moving with different velocity

5. Tell the student about the change of momentum on the black board giving the example of a moving body with initial velocity V_i and final velocity V_f and the change of velocities is $V_f - V_i$ and the change of momentum is $mV_f - mV_i$.
It is denoted as: $\Delta p/\Delta t = (mV_f - mV_i)$

6. Tell them that:
$\Delta p/\Delta t = (mV_f - mV_i)/\Delta t$ and $\Delta p/\Delta t$ is equal to the force applied on the body.

As $F = ma = m(V_f - V_i)/\Delta t = (mV_f - mV_i)/\Delta t$
Thus the second law of motion can be explained with respect to change of momentum.

7. State and write on the black board the law of conservation of momentum.

8. Explain the law of conservation of momentum giving the example of two bodies of masses m_1 & m_2 moving with velocities u_1 & u_2 respectively before the collision and after some time the bodies collide and change the velocities to v_1 & v_2 and the total momentum before the collision is equal to the total momentum after the collision the equation is written as:
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

9. Ask some questions from the student for that involvement as
   i) Define momentum
   ii) How the momentum of moving body change
   iii) What is law of conservation of momentum?

Activity No 2

1. Tell the student that the collision of two bodies such that their kinetic energy and momentum both remain conserved is called elastic collision. Explain on the board with the velocities of bodies and the masses of the bodies.

2. Tell the student that the K.E. = $\frac{1}{2} m_1u_1^2$ & $\frac{1}{2} m_1v_1^2$ for 1st body and similarly for second body is $\frac{1}{2} m_1u_2^2$ & $\frac{1}{2} m_1v_2^2$.

3. Prove with the involvement of the student that the collision is elastic.

4. Tell the student about the inelastic collision.

5. Explain on black board 'the elastic collision in one dimension'.

6. Drive the equation on the black board.

$u_1 + v_1 = u_2 + v_2$ ____________ (1)

$$V_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) U_1 + \left(\frac{2m_2}{m_1 + m_2}\right) U_2 \quad \text{__________ (2)}$$

$$V_2 = \left(\frac{2m_1}{m_1 + m_2}\right) U_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) U_2 \quad \text{__________ (3)}$$

Tell, explain and if possible then demonstr5ate the special cases of collision of two bodies.

7. Ask some question from the students for involvement and interest.

   i) What is elastic collision?

   ii) What is inelastic collision?

   iii) What is the equation for K.E.?

   iv) Write the equation for v_1 & v_2 (the unknown velocities)

9. Ask the student to write the topic on the notebook

   At the end summarize

Summary

The summary of the topic is to know about the:

i) Momentum

ii) Change of momentum

iii) Law of conservation of momentum

iv) Elastic and inelastic collision of two bodies

v) Elastic collision in one dimension

vi) Special cases of collision of two bodies

Self-assessment

(*Note*: Each question has five marks)

Q.No.1. Define and explain linear momentum?

Q.No. 2. Explain second law of motion by change of momentum?

Q.No.3. Explain the change of momentum?

Q.No.4 Explain law of conservation of momentum?

Q.No.5 Define elastic collision, gave an example to support it?

Q.No.6 What is an inelastic collision?

Q.No.7 Prove

$$V_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) U_1 + \left(\frac{2m_2}{m_1 + m_2}\right) U_2 \qquad (1)$$

Q.No.8 Prove

$$V_2 = \left(\frac{2m_1}{m_1 + m_2}\right) U_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) U_2 \qquad (2)$$

Q.No.9 Explain the special cases of moving bodies?

Q.No.10 Define elastic collision in one dimension?

Score Chart

Q.No	1	2	3	4	5	6	7	8	9	10
Marks										

Lesson No. 2

Concept: **VARIATION OF 'g**

Objectives of the concept

At the end of this lesson the student will be able to know about the:

1. Gravitational acceleration 'g'
2. 'g' is constant on the surface of earth
3. 'g' decreases as the body goes upward for from the center of earth
4. 'g' decreases as the body goes inside the earth
5. Application of 'g' in numerical problems

VARIATION OF 'g'

Required material: Chalk, Duster, Black board, Chart.

Content

'g' is the gravitational acceleration of the free falling bodies. It is constant on the surface of earth and its value is 9.8 m/sec^2. It is positive when the body is falling downward and negative when the body is moving upward.

However, the value 'g' varies on the surface earth and also varies as the body goes upward or when the body goes downward. In this topic we are to find the variation of 'g' on the surface of earth as well as when it goes upward or downward.

We know that the force with which the earth attracts the body of mass 'm' towards the center of earth is:

$F = G M_e m / r^2$ ________________ (1)

Where 'r' is the distance between the center of earth and body. Also the force of gravity toward the center of earth is

$F = mg$ ________________ (2)

Comparing both the equations

$mg = G M_e m / r^2$

Or $g = G M_e / r^2$ ________________________ (3)

Equation (3) gives the value of 'g'. It depend upon the 'G', the gravitational constant, 'M_e' the mass of earth, also constant and 'r' the distance of the bodies from the center of earth. This shows that

$g \propto 1/r^2$ ____________________ (4)

Equation (4) explains that when the distance of the body from the center of earth increases, the value of 'g' decreases and vice versa.

When the bodies on the surface of earth as shown in given figure then the distance: $r = R_e$, then:

$g = G M_e m / R_e^{\,2}$

As G and M_e are constants.

Thus: $g \propto 1/ R_e^{\,2}$

As the earth is spherical in nature and its 'Re' is nearly is same for all the sides thus the value of 'g' is nearly constant over the surface of earth. However, when the polar axis is less than the equatorial axis, when value of 'g' is different for equatorial axis.

VARIATION OF 'g' WITH ALTITUDE

To define the relation for 'g' when the bodies move upward we assume body is at height 'h' above the ...rface of earth as shown in fig I:

The d... ...om the center of earth to the ...dy is (R_e+h) where Re is the rad...

The value of ... 'h' is:

$g_h =$ ... ____________ (1)

... the va... ... on the surface of earth is:

$g =$ ... ____________ (2)

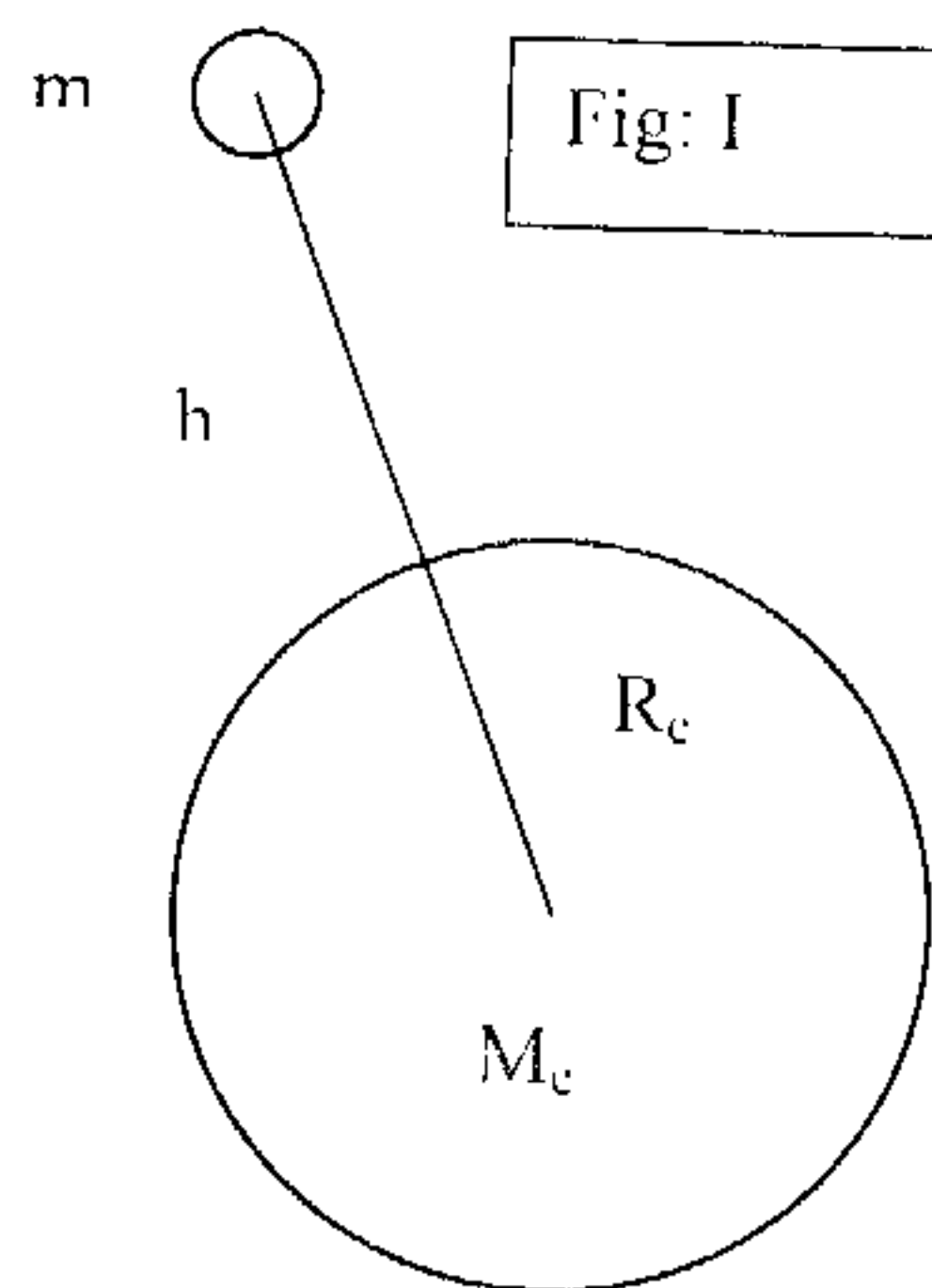
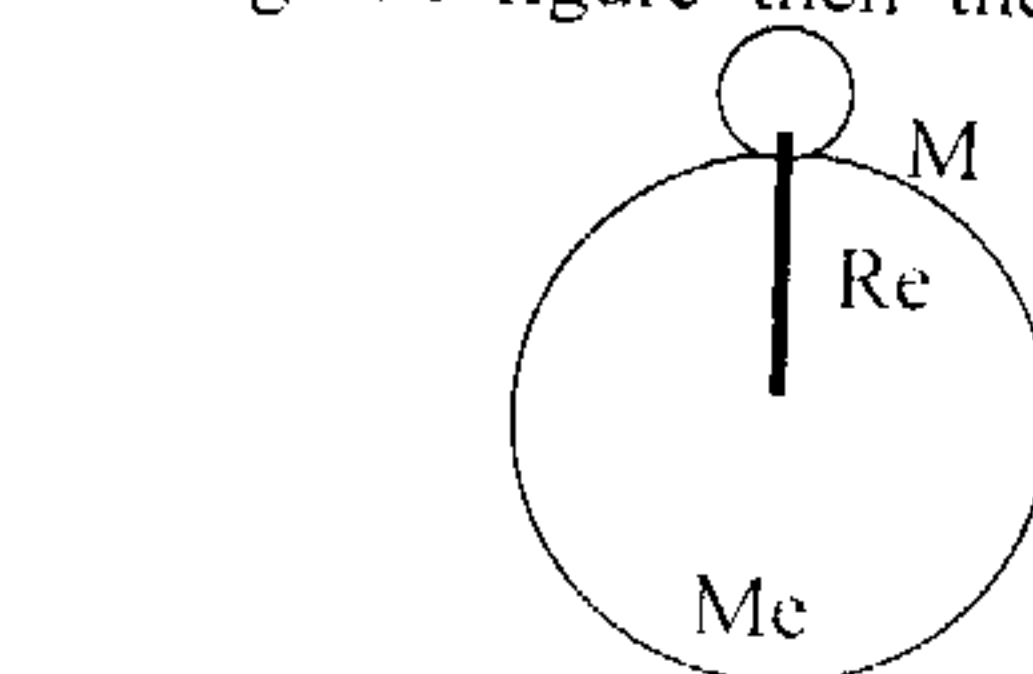
Dividing eq...

$g_h/g =$ ... M_e/R... $(R_e+h)^2 = R_e^2/ R_e^2(1+h/R_e)^2$

$g_h/g = 1$...

$g_h/g = 1/(1+h/R_e)^{-2}$ ____________ (3)

Using the Binomial The... ...on equation (3) we have:

$g_h/g = 1/(1-2h/R_e)$

$g_h = g/(1-2h/R_e) = g - 2gh/R_e$

$g_h = g - 2gh/R_e$ ________________ (4)

Equation (4) gives the value of gravitational acceleration at distance 'h' above surface of earth. As the 'h' goes on increasing, the value of 'g' goes decreasing by a factor $2gh/R_e$.

For example the value of 'g' at height h = 16 Km above is:

$g_h = 9.8 - (2 \times 9.8 \times 16)/6400 = 9.75\ m/sec^2$.

This value reduces to zero when $h = R_e/2$ i.e. the body is at a distance half the radius of earth. At this:

$g_h = g - (2gR_e/2\ R_e) = g - g = 0$

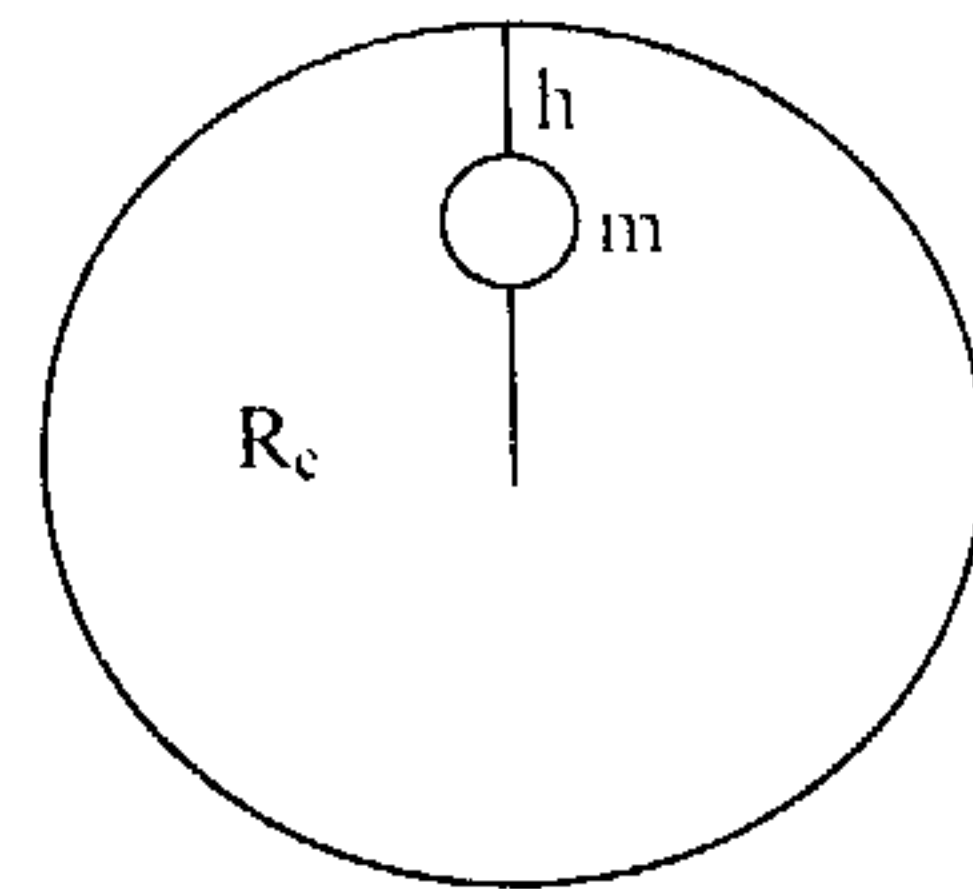
$g_h = 0$ ________________ (5)

Variation of 'g' with depth, below the surface of earth

In this case we are to study the value of gravitational acceleration when the body is in Re depth of earth as in given figure. For this study we use Re same formula as:

$g = GM_e/R_e^2$ ________________ (1)

$g' = GM_e/(R_e - h)^2$ ________________ (2)

As M_e is the mass of earth & in both it is R_e same, but practically when the body is in depth 'h' below the earth then M_e is the mass of the earth inside that body, so we take the density of earth for both the value. For equation (1)

M_e = Volume of earth x density

As earth is spherical in nature so:

$V = 4/3\ \pi\ R_e^3$, thus $M_e = 4/3\ \pi\ R_e^3 l$ & $M_e' = 4/3\ \pi\ (R_e - h)^3 l$. Putting these values in equation (1) & (2) respectively we have:

$g = G \times (4/3\ \pi\ R_e^3 l)/Re^2 = 4/3\ G\ \pi\ R_e l$ ________________ (3)

$g_h = G/(R_e - h)^2 \times 4/3\ \pi\ (R_e - h)^3 l = 4/3\ G\ \pi\ (R_e - h) l$ ________________ (4)

Dividing (4) by (3) we have

$g_h/g = \{4/3\ G\ \pi\ (R_e - h) l\}/\{4/3\ G\ \pi\ R_e l\}$

$g_h/g = (R_e - h)/R_e$

$g_h/g = R_e(1 - h/R_e)/R_e = (1 - h/R_e)$

$g_h = g(1 - h/R_e) = g - gh/R_e$ ______________ (5)

Equation (5) gives the value of gravitational acceleration in the depth (h) of the earth. As the body goes inside the earth the (g) decreases by e factor g_h/R_e & this value reaches to zero where h = R_e. i.e. the body reaches at the center of the earth. Mathematically:

$g_h = g - gR_e/R_e = g - g = 0$

$g_h = 0$ ______________ (6)

The detail study of gravitational acceleration tells us the 'g' decreases in both cases, for upward & for downward & is constant on the surface of earth.

Numerical Problem:

At what altitude above the surface of earth, the acceleration of gravity is $4.9 m/sec^2$. The mass of earth is 6×10^{24} Kg and Radius is 6.4×10^6 m?

Given Data:

In this problem the given data is:

$g_h = 4.9 \text{ m/sec}^2$

$M_e = 6 \times 10^{24}$ Kg

$G = 6.67 \times 10^{-11}$

$R_e = 6.4 \times 10^6$ m

Unknown Value:

$h = ?$

Formulae:

We have the formulae as:

$g_h = Gm_e/(R_e+h)^2$

$(R_e+h)^2 = GM_e/gh$ or $R_e + h = \sqrt{GM_e/gh}$

Or $h = (\sqrt{GM_e/gh}) - R_e$ ______________ (1)

Solution:

Putting the values we have

$\Rightarrow \sqrt{(6.67 \times 10^{-11} \times 6 \times 10^{24} / 4.9)}$

$\Rightarrow \sqrt{(6.67 \times 6 \times 10^{13} / 4.9 \times 10)} - 6 \times 10^6$

$\Rightarrow \sqrt{(8.16 \times 10^{12}) - 6 \times 10^{6}}$

$\Rightarrow 9.03 \times 10^{12} - 6 \times 10^{6}$

$\Rightarrow 3.03 \times 10^{6}$ m

$\Rightarrow 3.03 \times 10^{3}$ Km

$\Rightarrow$ 303 x 1000 / 100 Km

$\Rightarrow$ 3030 Km (Answer)

METHODOLOGY

Instruction for Teacher:

1. Divide the topic in two Periods
2. Use black board
3. Teach the topic as in given activities
4. Practically prove in the class that $g = 9.8\ m/sec^2$ & constant on the surface of earth

Activity No.1

On entering the class:

1. Ask some questions about the gravitational acceleration from the students as:
   i) What is 'g'?
   ii) What is its value on the surface of earth?
   iii) Why it is constant?
2. After asking the question & finding the answer of these questions write the topic on the black board as:

VARIATION OF 'g'

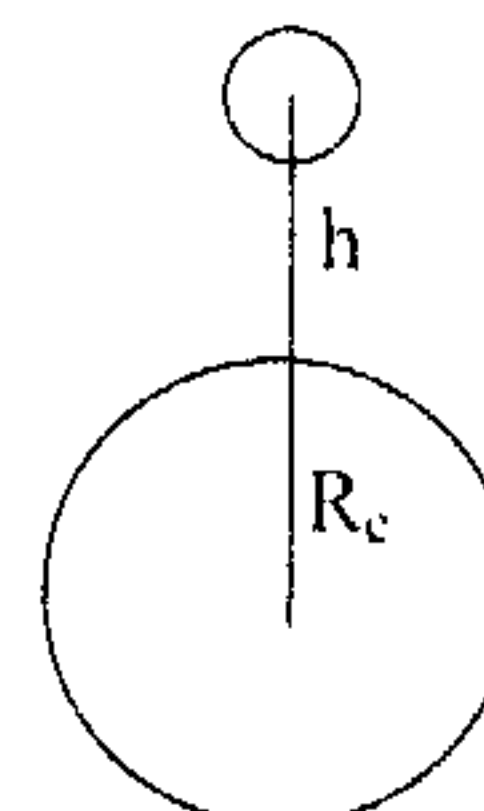
3. Tell the students that it is constant on the surface of earth and its value is $9.8 m/sec^2$. However, the values of this 'g' vary as the bodies goes upward or downward.
4. Tell the students that the value of 'g' depend upon the 'G' Gravitational constant, mass of earth and the distance of the body from the center of earth. Write mathematically as:

$$g = GM_e/R^2 \quad \text{____________} \quad (1)$$

As G & M_e are the constant so: $g \propto 1/R^2$

5. Tell the students that the polar axis are less than the equatorial axis, so it is different on equatorial axis.
6. Tell & explain the students on the black board that when the body is at distance 'h' above the surface of earth it decreases as:

$$g_h = g - 2gh/R_e \quad \text{____________} \quad (2)$$

7. Draw the figure to show the body at 'h' above the earth.
8. Ask some question from the students as:
   i) What are the responsible components of 'g'

ii) Derive the equation on the black board

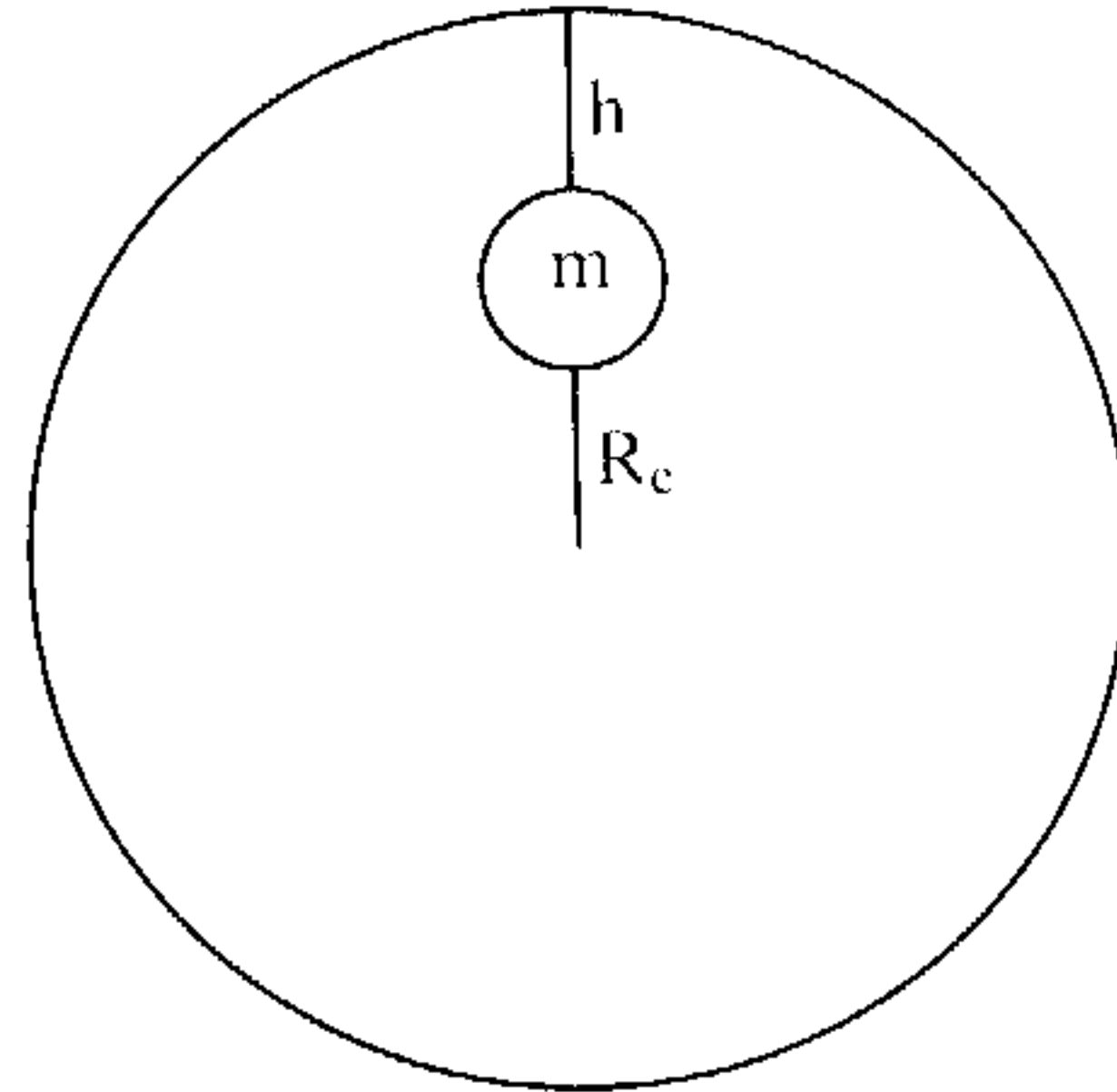
$g = GMe/Re^2$

iii) Prove that $g_h = g - 2gh/Re$

9. Ask the students to write the topic on the notebook.

Activity No. 2

1. Tell the students that as the body goes inside the surface of earth, the value of 'g' also decreases.

2. Draw the figure showing body inside the surface of earth as:

3. Tell the students that as the body goes inside, its density changes & the 'g' depend upon the density of the earth.

4. Tell and explain on the black board that the value of 'g' inside the earth is:

$g_h = g - 2gh/R_e$

5. Prove that g = 0 in the center of earth.

6. Solve the numerical problem relating to 'g' on the blackboard with the help of the students.

7. Ask the students to write the topic on your notebook.

Summary:

Ask some one from the students to summarize

In this topic we study about the:

i) Gravitational Acceleration

ii) Gravitational Constant

iii) 'g' is constant on the surface of earth

iv) Its value is $9.8\ m/sec^2$.

v) 'g' is inversely proportional to the distance from the center of earth to the center of the body.

vi) 'g' decreases when the body goes upward & decreases when the body goes inside the surface of earth.

vii) Application of formula for numerical problem

viii) Awareness about the structure of earth

Self-Assessment Questions:

(*Note:* Each question have 5 marks)

Q.No.1: What is `g` & why it is constant?

Q.No.2: Write & prove that $g = GMe/r^2$?

Q.No.3: What happen when a body is at distance `h` above the surface of earth?

Q.No.4: Prove that $g_h = g - 2gh/Re$.

Q.No.5: Prove that $g' = g - gh/Re$.

Q.No.6: When g = 0 for inside the earth.

Q.No.7: What is the radius of earth?

Q.No.8: What is g at height h = 16 Km above the surface of earth?

Score Box

S.No.	1	2	3	4	5	6	7	8	Total
Marks									40

Note: If the score is less than 40. then for guidance study as for:

Q.No.1		Q.No.5	
Q.No.2		Q.No.6	
Q.No.3		Q.No.7	
Q.No.4		Q.No.8	

Lesson No 3

Concept: CAPACITORS

OBJECTIVES

The Objectives of the concept are:

i) To know about the conducting materials.

ii) To know about the Capacitor, device for storing electrical charges.

iii) To know about the combinations of Capacitors as Parallel plate & series capacitors.

iv) To know about the Capacitance of Capacitor.

v) To know about the use and application of capacitor in daily life.

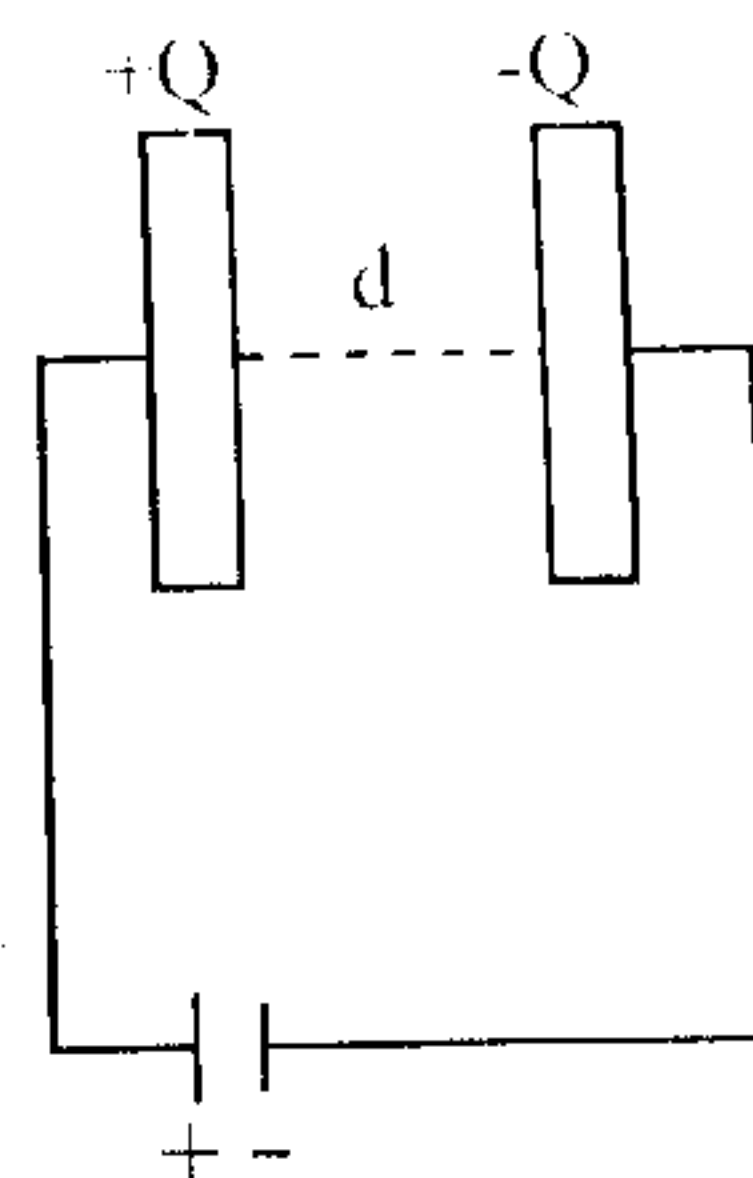
REQUIRED MATERIAL:

Chalk, Duster, Blackboard, Cell, Battery Connection Wires, Radio, Capacitors.

Content:

CAPACITOR

A device used to store electrical charges is called Capacitor. In simplest form: it is consist of two parallel plates of conducting material separated by a small distance between them as shown in given figure:

The plates of the capacitor are charged by rubbing them with a suitable material or by connecting them to a battery or cell. The plate connected to the positive terminal of the battery is called positive plate and connected to negative terminal of the battery is called negative plate. If the capacitor store "Q" charges it mean +Q are store on the +ve plate and –Q are store on –ve plate. These charges remain on the inner surface of the plates until the plates are connected to the resistor or bulb for external use. The bulb will remain light up until the charges ends on the plates.

The capability of a capacitor to store the charges is called capacitance of a capacitor. Experimentally it was observed that the amount store on the capacitor depends upon the P.d between the

Mathematically.

$Q \propto V$

$\Rightarrow$ $Q = CV$ ______________________________ (1)

'C' is constant of proportionality, called capacitance of the capacitor.

Or $C = Q/V$ ______________________________ (2)

It is a physical quantity can be measured its unit for measurement is SI system is coulombs / Volt, called Farad denoted by "F" & defined as the capacitance of a capacitor is one Farad when one coulombs charges are store on each plate such that the P.d between them is one volt.

Farad is a big unit, its sub multiple units are

Micro Farad $= 10^{-6}$ F

Pico Farad $= 10^{-12}$ F

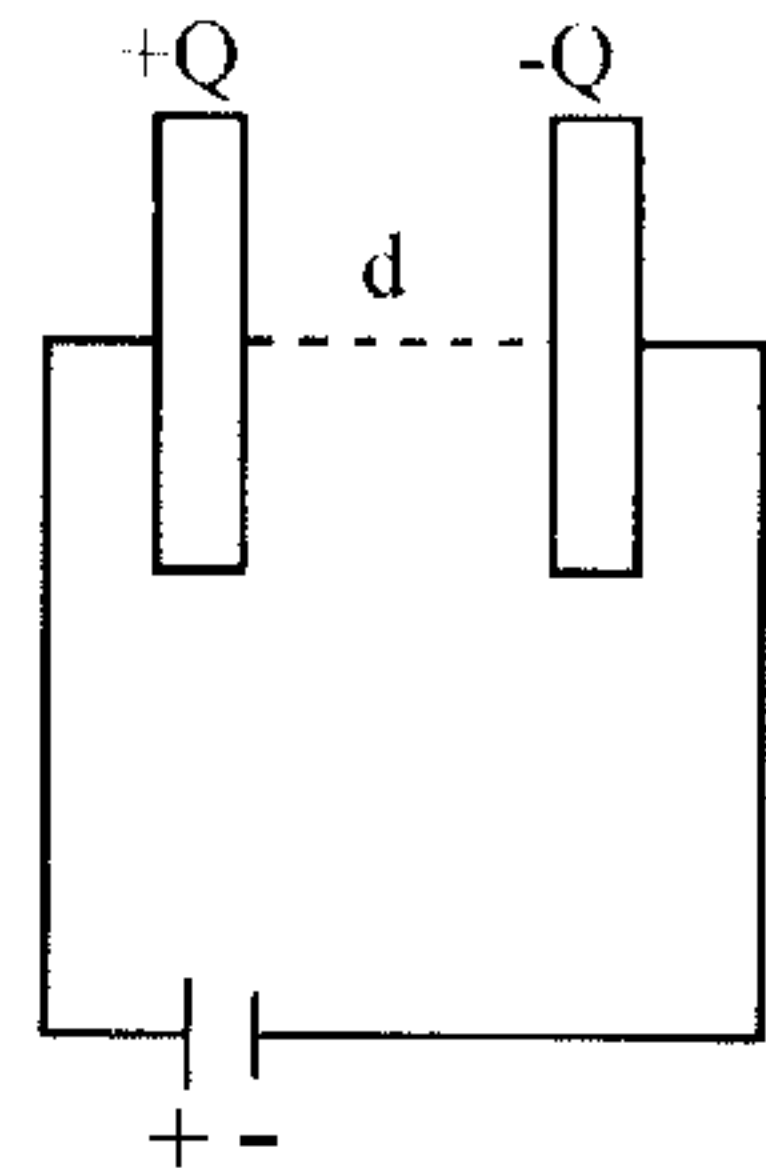
Capacitance of Parallel Plates Capacitor:

A capacitor, which is made by the combination of parallel plates, called parallel plates capacitor. Pictorially it is shown as in given figure:

The distance between the plates is 'd' and the space between the plates is air, then the capacitance is:

$C = Q / V$ ______________________ (1)

It is known that, if 'E' is the electric intensity between the plates and 'd' the distance then $V = -Ed$ __________ (2)

It is also known that the electric intensity between the plates is:

$E = \delta / \in_o$, where 'δ' is charge density as $\delta' = \theta/A$ & $\in_o$ is the permibility of free space, then:

$E = \theta/A\in_o$ putting this in equation (2) we have:

$V = -Ed = \theta d/A\in_o$ & putting the value of V in equation (1):

$C = Q/V = (Q/Qd)/A\in_o = A\in_o/d = (A/d)\in_o$

$\Rightarrow \quad C = (A/d)\in_o$ ___ ___ ___ (3)

Equation (3) gives the value of capacitance of || plates capacitor. It show that the capacitance of || plate capacitor depend upon area & distance between the plates. It is directly proportional to area & inversely proportional to distance.

If there is some insulating material between the two plates called di-electric, then the capacitor is:

$C' = A\in_o \in_r/d$ and this is less than C by amount $\in_r$.

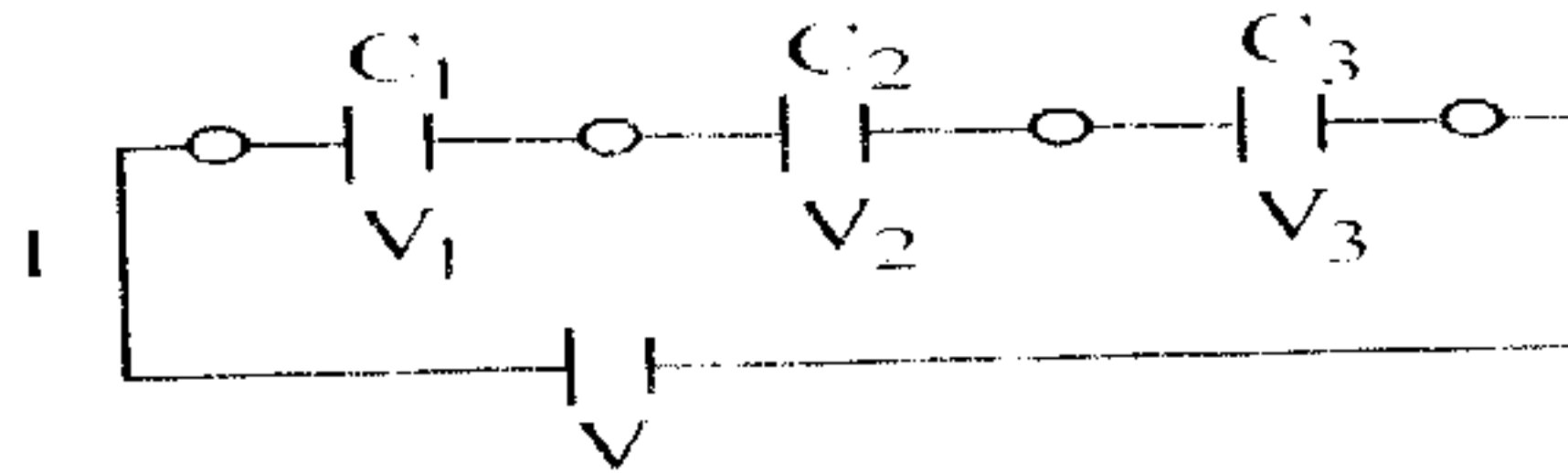
Combination of Capacitor:

There are two types of combination:

i) Series Combination

ii) Parallel Combination

i) Series Combination:

When two capacitors are connected in series with each other, it is called series combination. It is pictorially shown as:

In this combination there is only one way for the flow of current and in this combination same amount of charges are store on each plate. For C_1, the left hand plate is connected to the positive terminal of the battery & gets positive 'Q' charges at the same time. The R.H. plates of C_1 attract electron from the L.H. plate of C_2 and becomes negative plate by attracting equal amount of electron from the C_2 and in this way the L.H. plate of C_2 becomes equal from the L.H. plate of C_3 and the L.H. plate of C_3 becomes the negative terminal of the battery.

In this combination the P.d. across each plate is different. However, the sum of P.d. across all the capacitors is equal to the P.d. supplied as:

$V = V_1 + V_2 + V_3$ ___ ___ ___ ___ (1)

Such that:

$V_1 = Q/C_1, V_2 = Q/C_2, V_3 = Q/C_3.$

Then:

$V_1 + V_2 + V_3 = Q/C_1 + Q/C_2 + Q/C_3$

If 'V' is the voltage supplied and 'C' is the equivalent capacitance then:

$V = Q/C_e$, putting in equation (1) we have:

$\Rightarrow$ $Q/C_e = Q(1/C_1 + 1/C_2 + 1/C_3)$

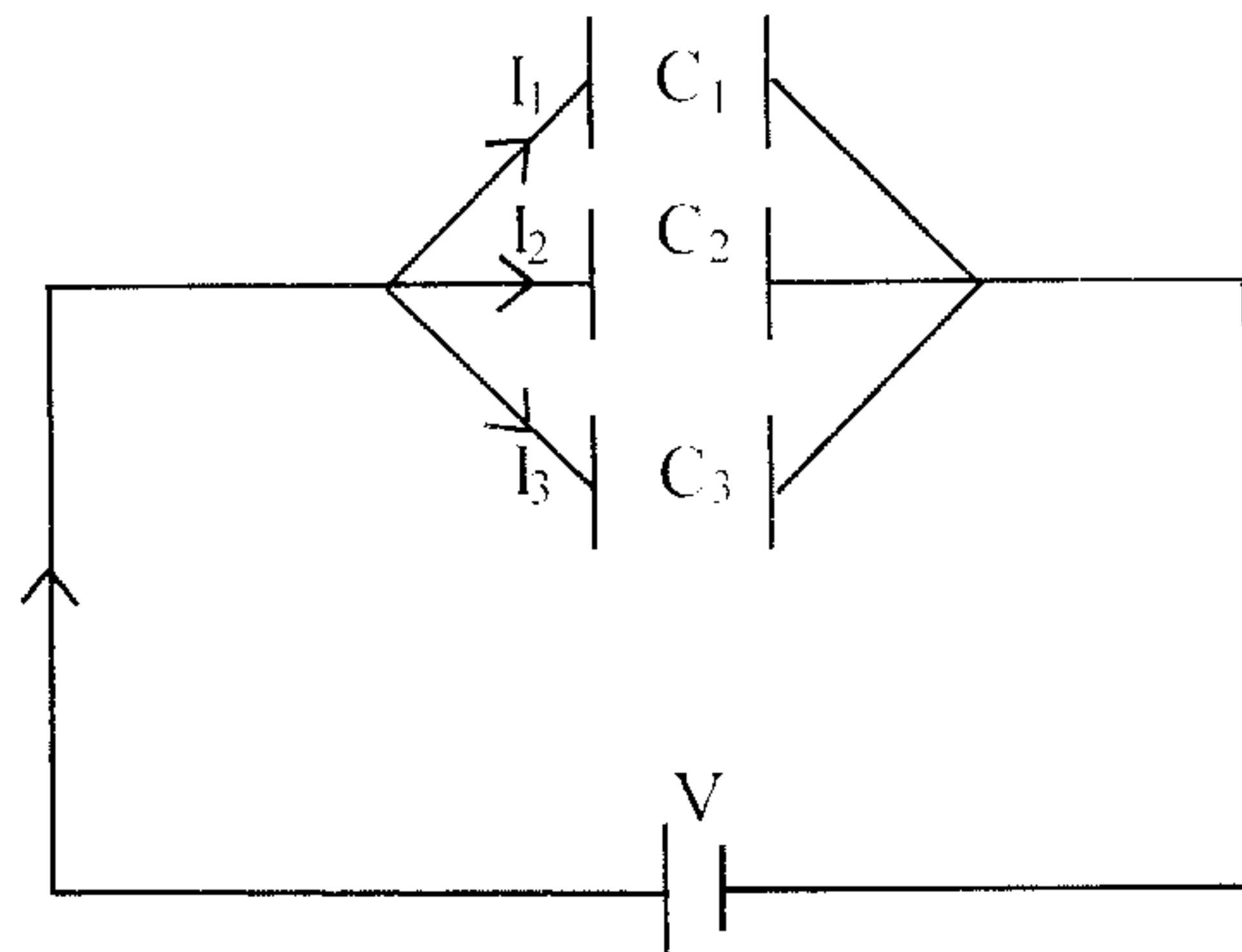
Or

$\Rightarrow$ $1/C_e = 1/C_1 + 1/C_2 + 1/C_3$

$\Rightarrow$ $$1/C_e = \sum_{i=1}^{n} 1/C_i$$

Equation (2) gives the formula for series combination of capacitor. In this combination the equivalence capacitance is decreased by the lowest of series combination.

ii) <u>Parallel Combination of Capacitors:</u>

When two or more capacitors are connected in parallel with each other, called parallel combination.

In parallel combination, each capacitor is connected directly to the voltage source and the charge store on each capacitor is different. The charge store on C_1 is Q_1, on C_2 is Q_2, and on C_3 is Q_3.

However, the total charge store on the combination is:

$$Q = Q_1 + Q_2 + Q_3$$

Such that:

$$Q_1 = VC_1, Q_2 = VC_2, Q_3 = VC_3,$$

$$Q = VC_1 + VC_2 + VC_3$$

$$= V(C_1 + C_2 + C_3)$$

If $Q = C_eV$

Then:

Or $C_eV = V(C_1 + C_2 + C_3)$

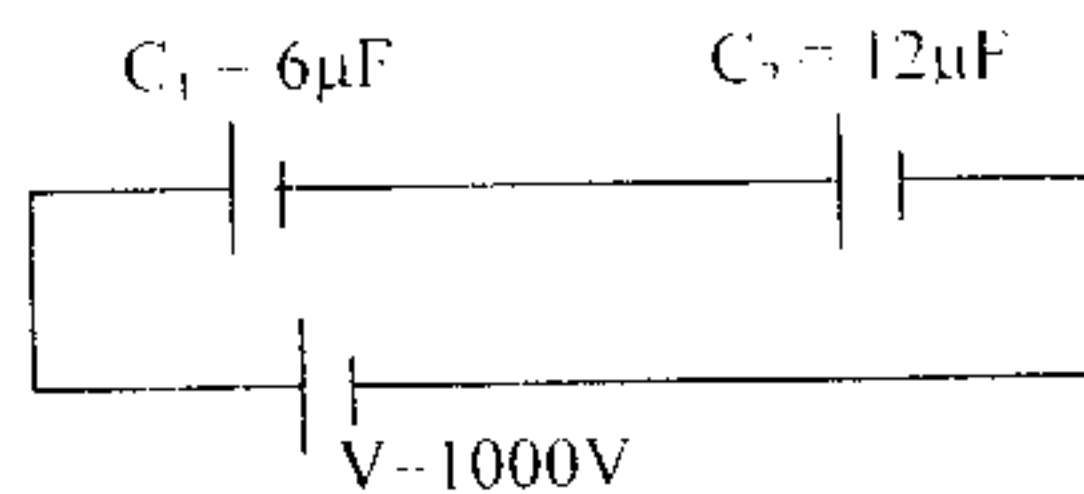
$\Rightarrow$ $C_e = (C_1 + C_2 + C_3)$

$\Rightarrow$ $C_e = \sum_{i=1}^{n} C_i$ ______ ______ ___(1)

In this combination the equivalent capacitance is increased by the highest of the capacitors connected in parallel.

Example

Two capacitors $C_1 = 6\mu F$ & $C_2 = 12\mu F$ are 1st connected in series and then in parallel. In each case the external voltage is 1000V, calculate in each case, total capacitance, potential drop across each capacitor.

a. *When the capacitance connected in series as:*

Solution:

If C_e is the equivalent capacitance then:

$$1/C_e = 1/C_1 + 1/C_2$$

$$= 1/6 + 1/12$$

$$= \frac{2+1}{12}$$

$$= 3/12$$

$$= 1/4$$

Or $C_e = 4\mu F = 4 \times 10^{-6}$ F

In this combination the charge store on each capacitor is the same as:

$$Q = C_e V$$

The moveable capacitors are of various kinds but the simplest one is parallel plates capacitor. The other kinds of it are spherical and cylindrical capacitors.

In spherical capacitors the plates are two co-axial metallic cylindrical shells separated by air or some other insulating material called di-electric.

2 **Fixed Capacitors:**

The capacitor whose capacitance is fixed are called fixed capacitor. These are commercial type capacitors and they are also made by the combination of two plates that are fixed and packed. These are of various kinds but the familiar ones are explained below.

i. **Tubular capacitor**

The capacitor that is made by two thing metal foils separated by a sheet of paper or plastic film and rolled up into small package.

ii. **Electrolytic Capacitor**

This capacitor consist of two aluminum plates, used as cathode and anode, that are dipped in ammonium borate solution and when current is passed, a thin film of Al_2O_3 is formed on the +ve plate and this film act as a dielectric between the plate and the solution. This capacitor is called Electrolyte capacitor. In this capacitor the thickness is small and the capacitance is large.

iii. **Miniature Capacitor**

A capacitor that are very small in size are called miniature capacitor. From the name it is of small size. Now a day there are commonly used in electrical circuits of modern technology as in computer, etc.

METHODOLOGY

Instructions for Teacher:

1. Divide the concept in two periods.
2. Use Block Board.
3. Demonstrate the available required material to the student
4. Teach the concept as in the given activities

Activity No. 1

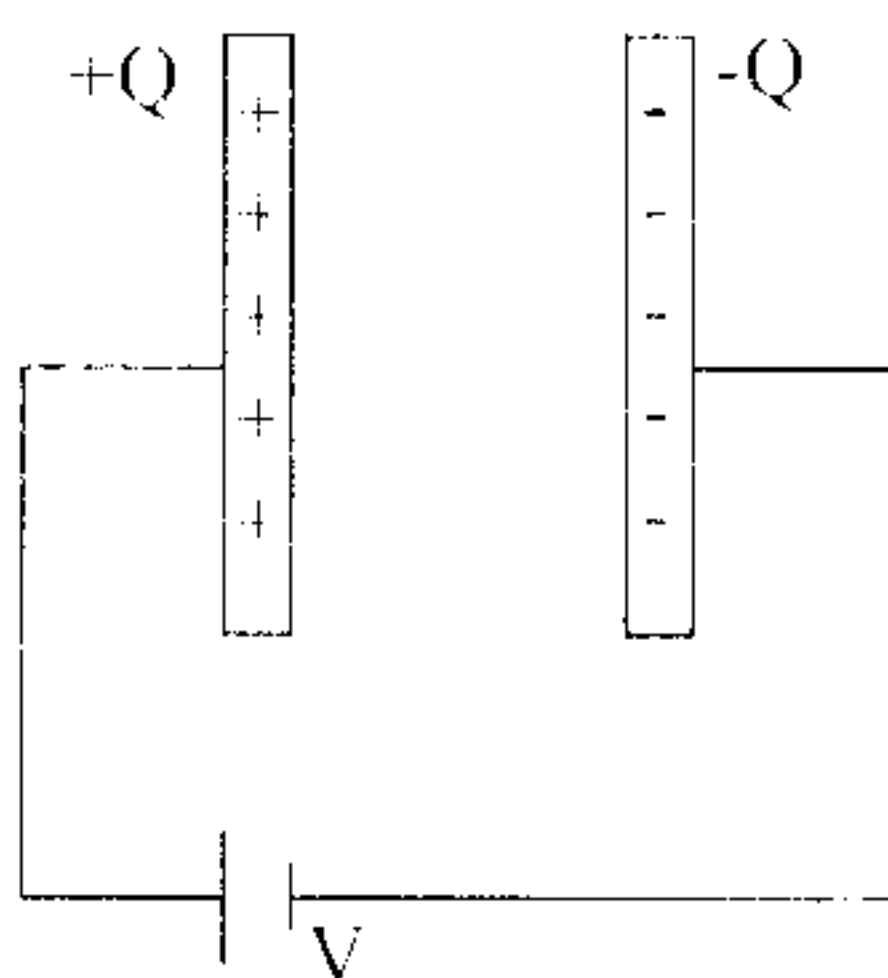
On entering in the class:

1. Ask some questions from the students about their previous knowledge as
   - i. What is conductor?
   - ii. What is charge?
   - iii. How the charge is store on the conducting plates?
2. Knowing the answer of the last question write the topic on the blackboard as:

CAPACITOR

3. Tell the students that capacitor is a device that can store electrical charges. In simplest form it consist of two parallel metal plates of conducting material separated by a small distance between them.

The plate on which the positive charges are store, is called +ve. plate & the plate on which the –ve. charges are store is called –ve. plate.

4. Draw the diagram of the capacitor as:

5. Tell the students that the capability of capacitor to store the charges is called capacitance & the capacitance of a capacitor depend upon the voltage source applied across the plates if "V" is voltage source & "Q" is the charge store then:

$Q \propto V$ or $Q = CV$ or

$C = Q/V$ _______________ (1)

"C" is constant of proportionality called capacitance of a capacitor. It depends upon the geometry of the plates and the medium between the plates.

6. Tell the students about the unit of capacitance as Farad and:

Farad = Coulomb/Volt

Its sub multiple units are

i) Micro Farad $= 10^{-6}$F

ii) Pico Farad $= 10^{-12}$F

7. Ask from the students the following questions:

i) What is Capacitor?

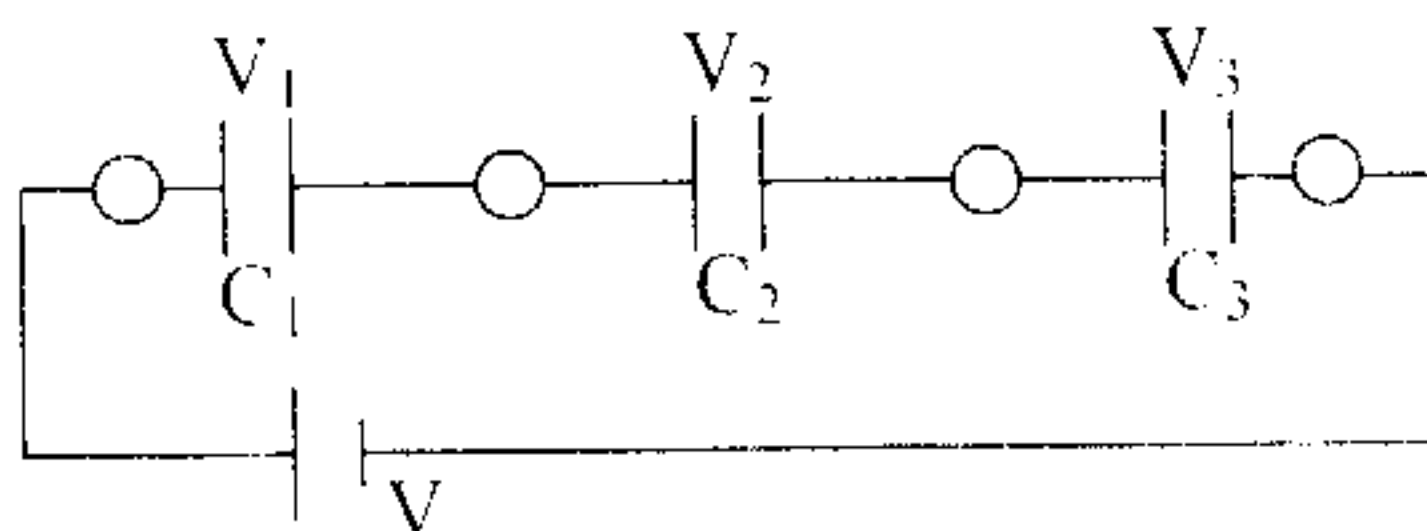
ii) What is Capacitance?

iii) What is Farad?

Activity No. 2

In this activity:

1. Tell the students about the combinations of capacitor that there are two types of capacitor called series combination & parallel combination.

2. Draw the circuit diagram of series combination on the blackboard as in given figure:

3. Tell the students from the diagram that in series combination, there is only one way for the flow of current and each capacitor store equal amount of charges. However, the potential difference across each capacitor is different. But the sum of their P.d. is always equal to V. Mathematically:

$V = V_1 + V_2 + V_3$ _______________ (1)

4. Write on the black board as:

$V_1 = Q/C_1$, $V_2 = Q/C_2$, $V_3 = Q/C_3$

Such that:

$V_1 + V_2 + V_3 = Q/C_1 + Q/C_2 + Q/C_3 = Q(1/C_1 + 1/C_2 + 1/C_3)$

If C_e is the equivalence capacitance and the voltage supplied then is $V = Q/C_e$

As:

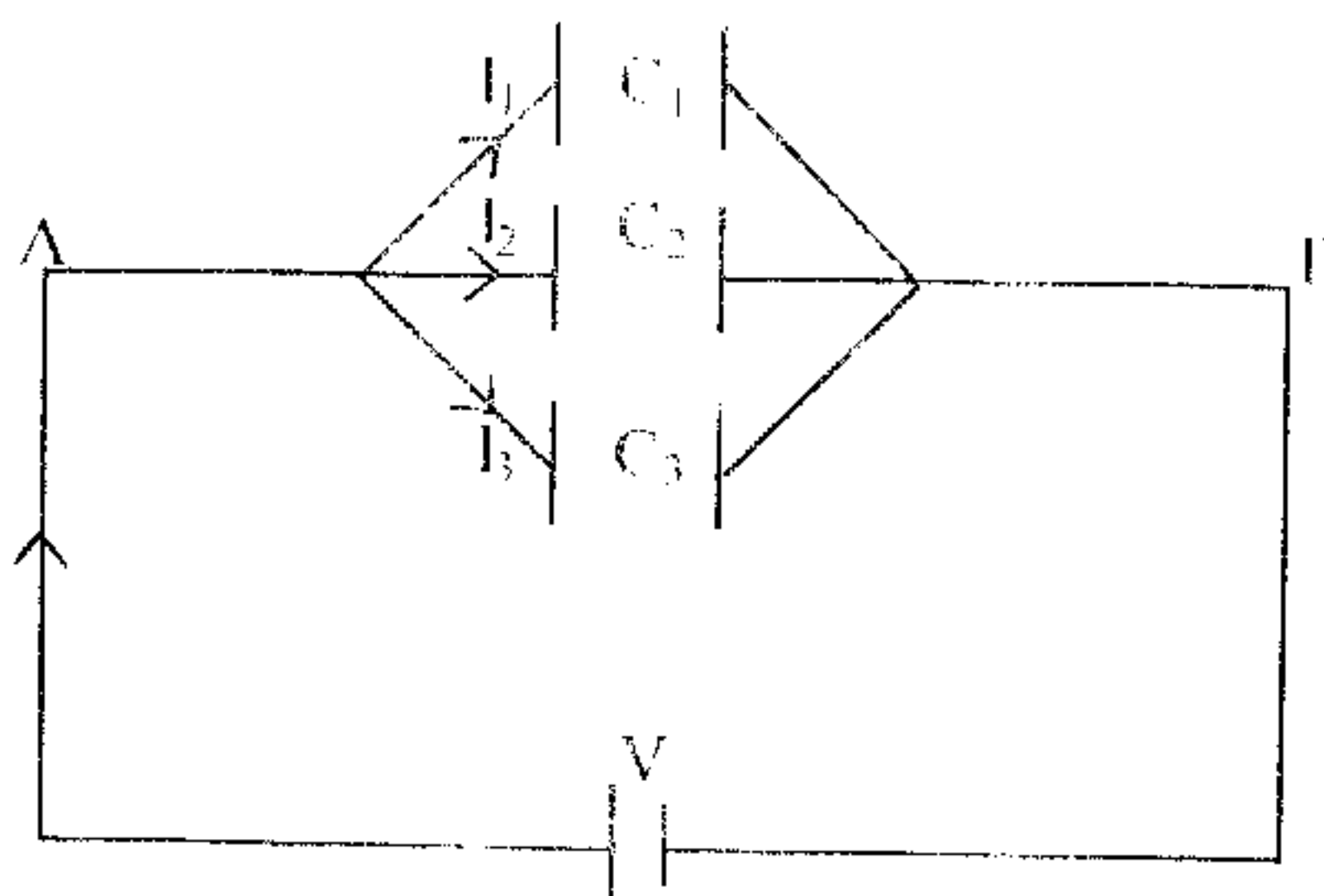
⇒ $V = V_1 + V_2 + V_3$

⇒ $Q/C_e = Q(1/C_1 + 1/C_2 + 1/C_3)$

⇒ $1/C_e = 1/C_1 + 1/C_2 + 1/C_3$

⇒ $1/C_e = \sum_{i=1}^{n} 1/C_i$ ______ ______ (2)

Equation (2) gives the equivalence capacitance when the capacitors are connected in series.

5. Draw the circuit diagram of parallel plate capacitance as:

6. Tell the students that is the circuit each capacitor is directly connected to the voltage source and each store different amount of charges on Q_1, Q_2, Q_3 such that the total charge store is $Q = Q_1 + Q_2 + Q_3$____ ______(1)

7. if V_1 is the P.d & C_1, C_2, C_3 are the capacitance then

$Q_1 = C_1V$, $Q_2 = C_2V$ & $Q_3 = C_3V$

Then $Q_1 + Q_2 + Q_3 = C_1V + C_2V + C_3V$

$Q = V(C_1 + C_2 + C_3)$

$VC_e = V(C_1 + C_2 + C_3)$

Or $C_e = C_1 + C_2 + C_3$

$C_e = \sum_{i=1}^{n} C_i$______________(2)

In this combination the equivalence capacitance in increased by the highest of capacitance in combination.

Solve some numerical problems on the black board involving the students.

Activity No. 3

1. Tell the students about the kinds of capacitors that there are two kinds of capacitor.

i. Variable capacitor

ii. Fixed capacitors

2. Draw the diagram of parallel plate capacitor, spherical plate capacitor and cylindrical plates capacitors.

3. Tell the students that the variable capacitors are used Radio, Television and the fixed capacitors are used in electrical instruments.

4. Ask some question from the students as

   i. How the fixed capacitor is formed?

   ii. What happen when the capacitor are connected in series?

   iii. Why the some amount of charge is store in series combination?

5. Summarize the topic as:

   In this topic we study about the capacitor, capacitance of a capacitor, dependence of capacitance, the medium between the capacitor, combination of capacitors called series combination and parallel combination. Numerical Problems of capacitance and kinds of capacitors.

Self-Assessment Question

(*Note:* Each question have 5 marks)

Q.No. 1 Define and explain the capacitor

Q.No. 2 Prove that C= A/d to for free space?

Q.No. 3 What is the unit of capacitance?

Q.No. 4 Derived formula for series combination & parallel combination?

Q.No. 5 Explain how the same amount of charge is store on each capacitor is series combination?

Q.No. 6 Why the P.d across each capacitor is deferent in series combination?

Q.No. 7 Why different amount of charges are store is parallel combination?

Q.No. 8 Explain variable capacitor?

Q.No. 9 What are miniature capacitors?

Q.No. 10 Define electrolyte capacitor?

Score Chart

Q.No.	1	2	3	4	5	6	7	8	9	10	Total
Marks											50

If the score is less then "50" then for guidance study as for

Q.No 1		Q.No 6	
Q.No 2		Q.No 7	
Q.No 3		Q.No 8	
Q.No 4		Q.No 9	
Q.No 5		Q.No 10	

Lesson No 4

Concept: AMPERE'S LAW

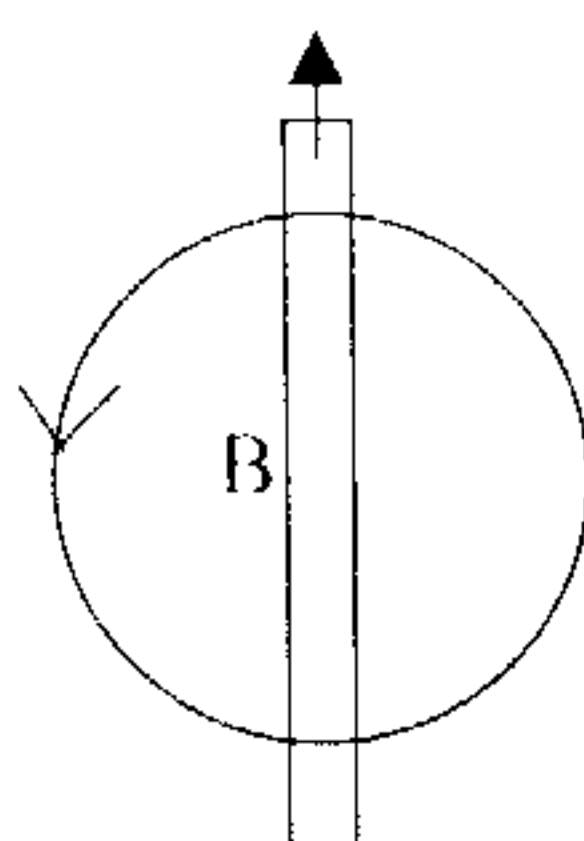
OBJECTIVES

The objectives of the topic are:

1. To know about the electro magnetic field.
2. To know abut the relation between field, current and distance of the field from the conductor is $B \propto I/r$.
3. Ampere's Law
4. Field due to Solenoid and its formula.
5. Field due to Toroid and its formula.
6. Method for solving the numerical problem using the Ampere's law and its application.

Requirement Material: Chalk, Black Board, Duster, Chart, Enameled, Copper Wire, Magnet, Rectangular frame of iron.

Content: AMPERE'S LAW

"It is a known fact that when the current I is allowed to Pass through the straight conductor, a magnetic field is produced around the conductor and the direction of this field is determined by Right hand thumb rule as shown in given figure."

The two scientists Biot & Saverat experimentally found that, the magnitude of magnetic field at any point "P" around the conductor is directly proportional to the amount of current I flowing through the conductor and is inversely proportional to the distance "r" from the center of conductor. Mathematically:

$B \propto I$ & $B \propto 1/r$

Combining $B \propto I/r$ or $B = K \times I/r$ ....(1)

K is constant of proportionality know as Biot & Saverat constant. Equation (1) is called Bio & Saverat laws.

Ampere's work on Biot & Saverat law. He replace k by $\mu_o/ 2\pi$ where μ_o is the permibility of free space and $2\pi r$ is the circumference of circular path. Putting $k = \mu_o/ 2\pi$ in equation.(1)

$B = \mu_o I / 2\pi r$

Or $B \times 2\pi r = \mu_o I$ ____________ (2)

Equation (2) is called Ampere's Law:

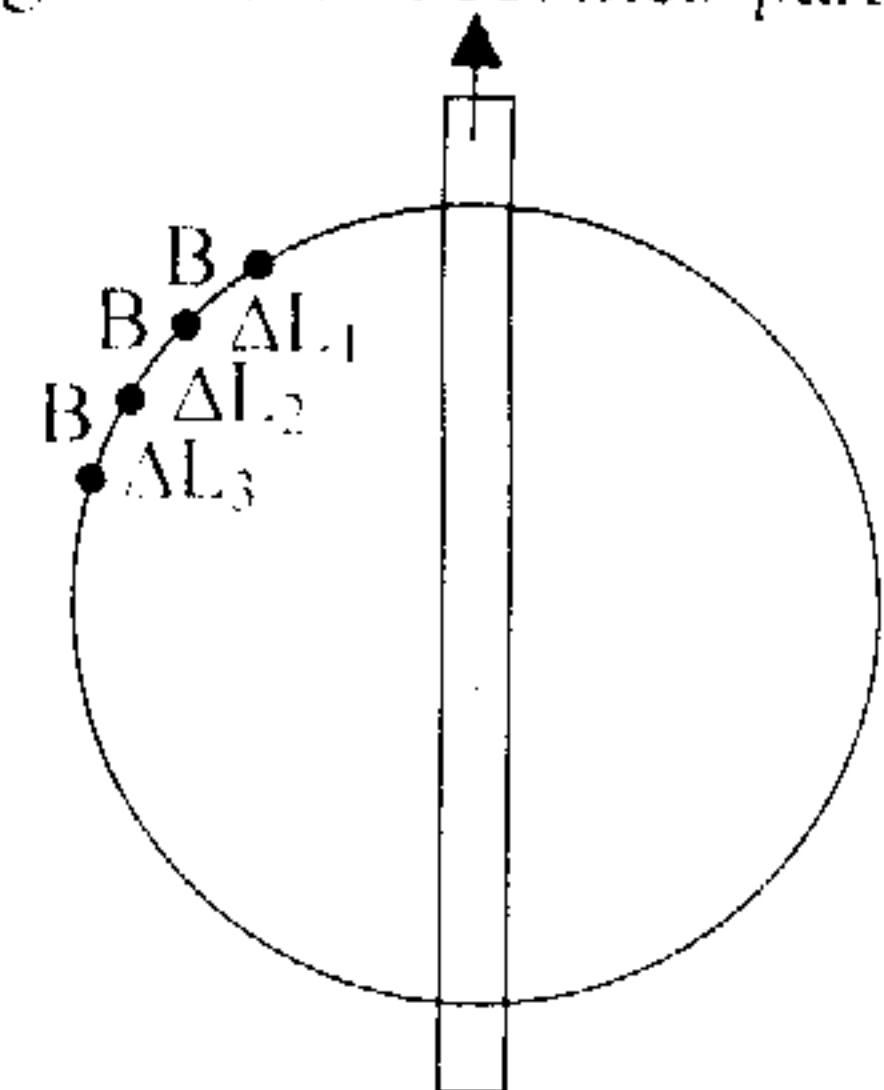
> *"It state that the product of magnetic field due to current carrying conductor and length of closed path around the current carrying conductor is always equal to the μ_o times the current flowing through the conductor."*

If $2\pi r = \Delta L$ (The length of the circular path). Then equation (2) is written as:

$B \times \Delta L = \mu_o I$ ____________ (3)

In Ampere's Law the difficult work is to find the product of B and ΔL.

For this, the possible technique is to divide the length of the path into number of small length segment so small that each segment is straight and B becomes parallel to each segment and constant for all the segments.

The length segments are ΔL_1, ΔL_2, ΔL_3, ---------- the direction of B at each length segment is of the circle is tagentional and parallel as in given figure:

Now find the product of B and each length segment as:

$B_{11} \times \Delta L_1 = B\cos\theta \times \Delta L_1$

Where $B_{11} = B\cos\theta$ and "θ" is the angle between length segment & B and $\theta = 0$ then $\cos\theta = 1$ then:

$B\cos\theta \times \Delta L_1 = B\,\Delta L_1$

Similarly for other length segment's we have

$B\,\Delta L_2,\ B\Delta L_3$,--------------------------

The total product is the sum of all these products as:

$B\Delta L_1 + B\Delta L_2\ B\Delta L_3 +$---------------- $+ B\Delta L_n$

$\Rightarrow \quad B\,(\Delta L_1 + \Delta L_2 + \Delta L_3 +$ ----------$+\Delta L_n)$

$\Rightarrow \quad B \sum_{i=1}^{n} \Delta L_i$

$\Rightarrow \quad B \times 2\pi r = \mu_o I$ ______________ (4)

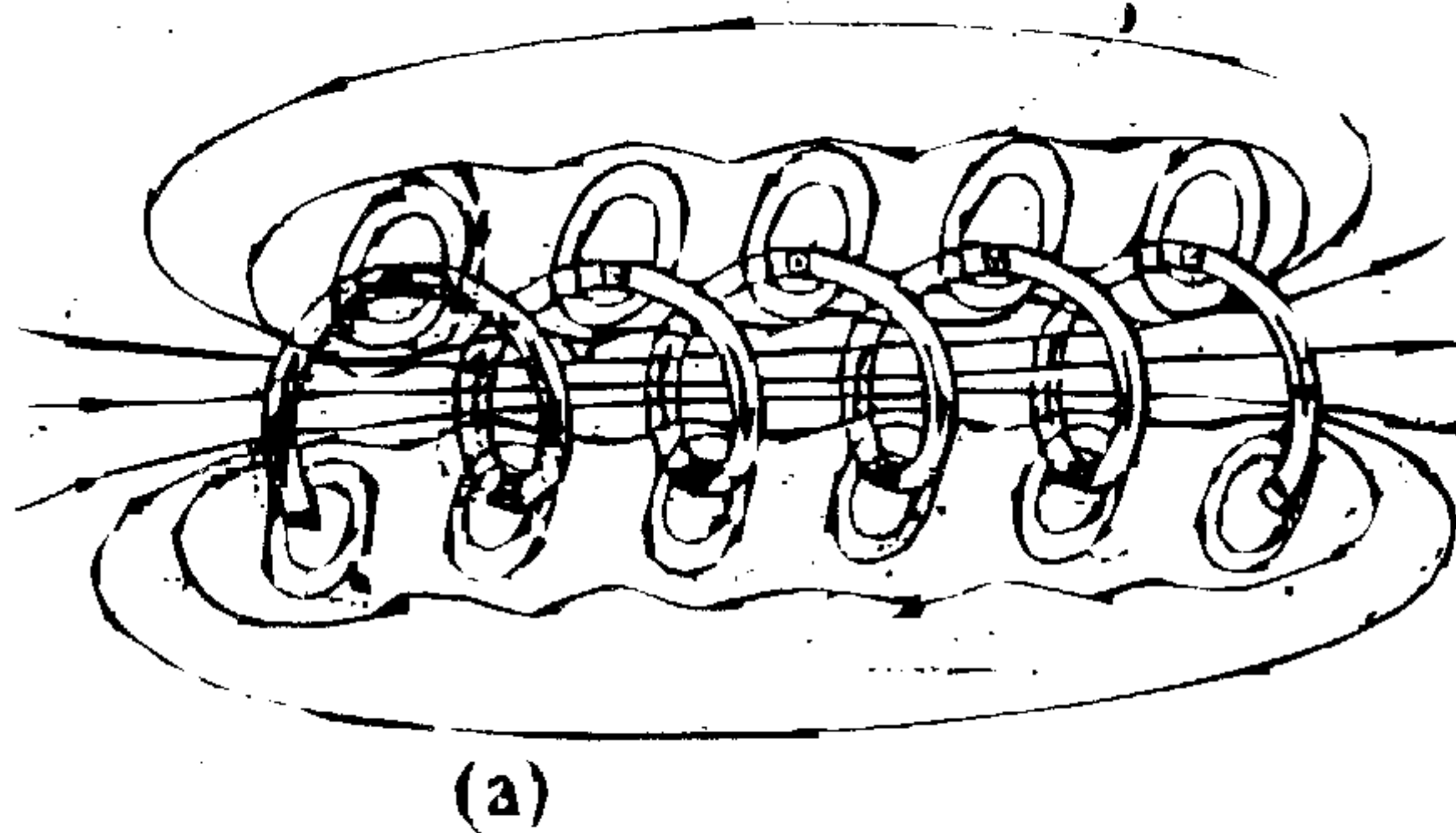
Which is an Ampere's law.

Application of Ampere's law

1. Field due to a Long Solenoid

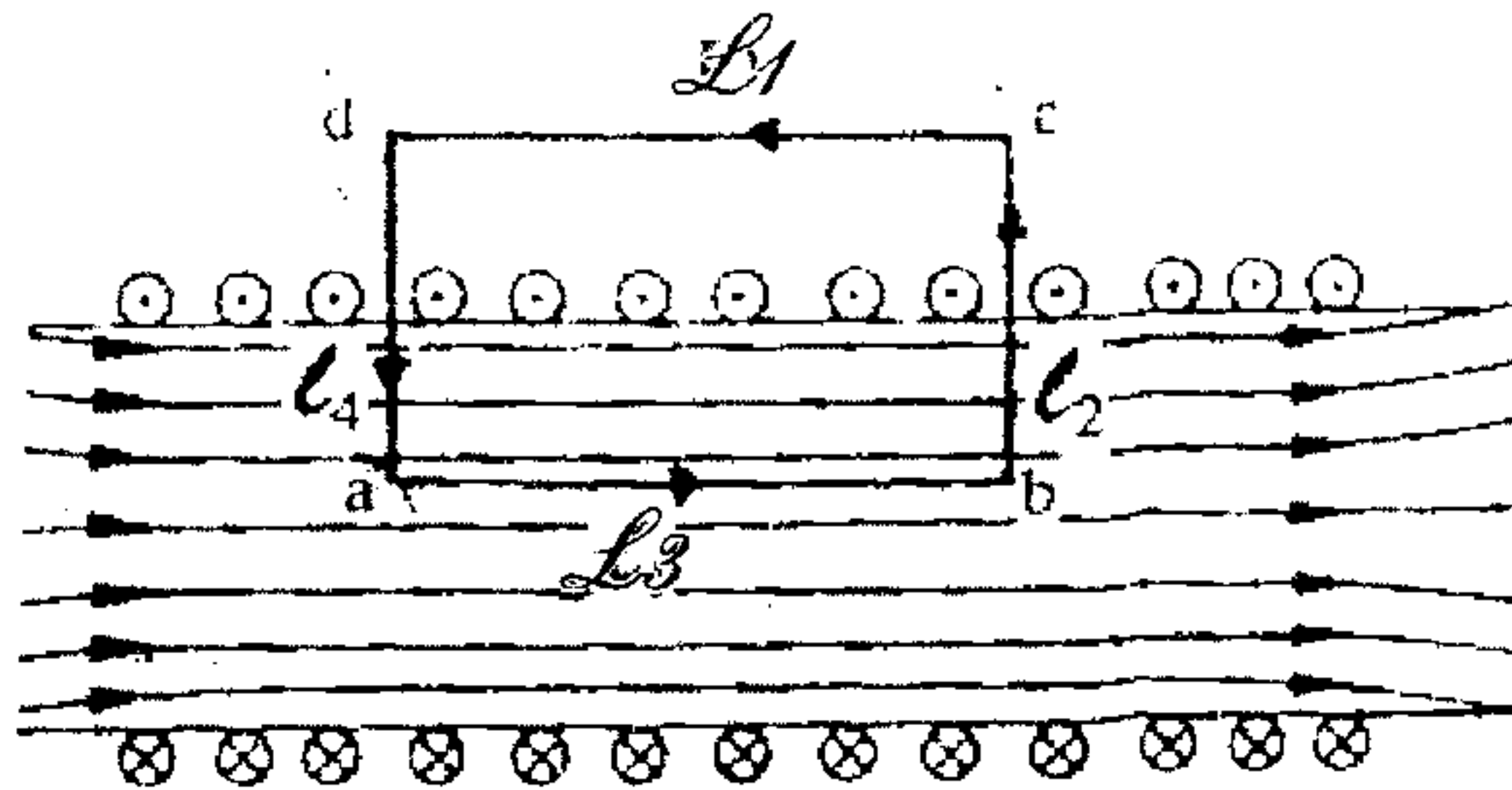
"A long tightly wounded insulating copper wire around a cylindrical frame of non magnetic material is called solenoid."

Pictorially it is shown as given below:

(a)

When current I is passed through the solenoid the magnetic field "b" is produced in the solenoid the direction of magnetic field at any point in the solenoid is according to right hand thumb rule.

Experimentally, it was found the field is stronger, uniform and uni-directional in the middle of the solenoid and negligibly weak out side the solenoid. the magnetic lines of forces are continuous. the magnetic lines of forces are continuous. the magnetic lines of forces are continuous, close to each other and unidirectional & are opposite to each other unidirectional & are opposite to each other at out side and conceal each other at out sides.

If we wants to calculate the magnetic field in the solenoid, we take a rectangular path abcda as shown in figure.(2)

Figure 2

Divide this rectangular path into four-length segments as L_1, L_2, L_3, and L_4 respectively and calculate the product of each length segment & B as for L1, the product is:

$B \times L1 = \mu_o I$

As L_1 lies out side the solenoid so $I = 0$

Hence $B \times L_1 = 0$

Now for L_2, the product is $B \times L_2 = BL_2 \cos\theta$, where θ is the angle between L_2 and B as L_2 is perpendicular to B then $\theta = 90$ and $\cos 90 = 0$

Then $B \times L_2 = 0$ Similarly $B \times L_4 = 0$

For L_3 we have $B \times L_3 = BL_3 \cos\theta = BL_3 (-1)$

$Bl_3 = \mu_o I$ or $Bl_3 = \mu_o I$

Negative sign is for opposite direction of length.

Now the product of B and total length is the sum of all these products as:

$BL_1 . BL_2 . BL_3 . BL_4 . = BL_3 + 0 + 0 + 0 = BL_3$

Or $\quad BL_3 = \mu_o I$ ____________(1)

If N is the number of turns of solenoid per unit length then for length L_3 there are NL_3 thus we have

$BL_3 = \mu_o I NL_3$

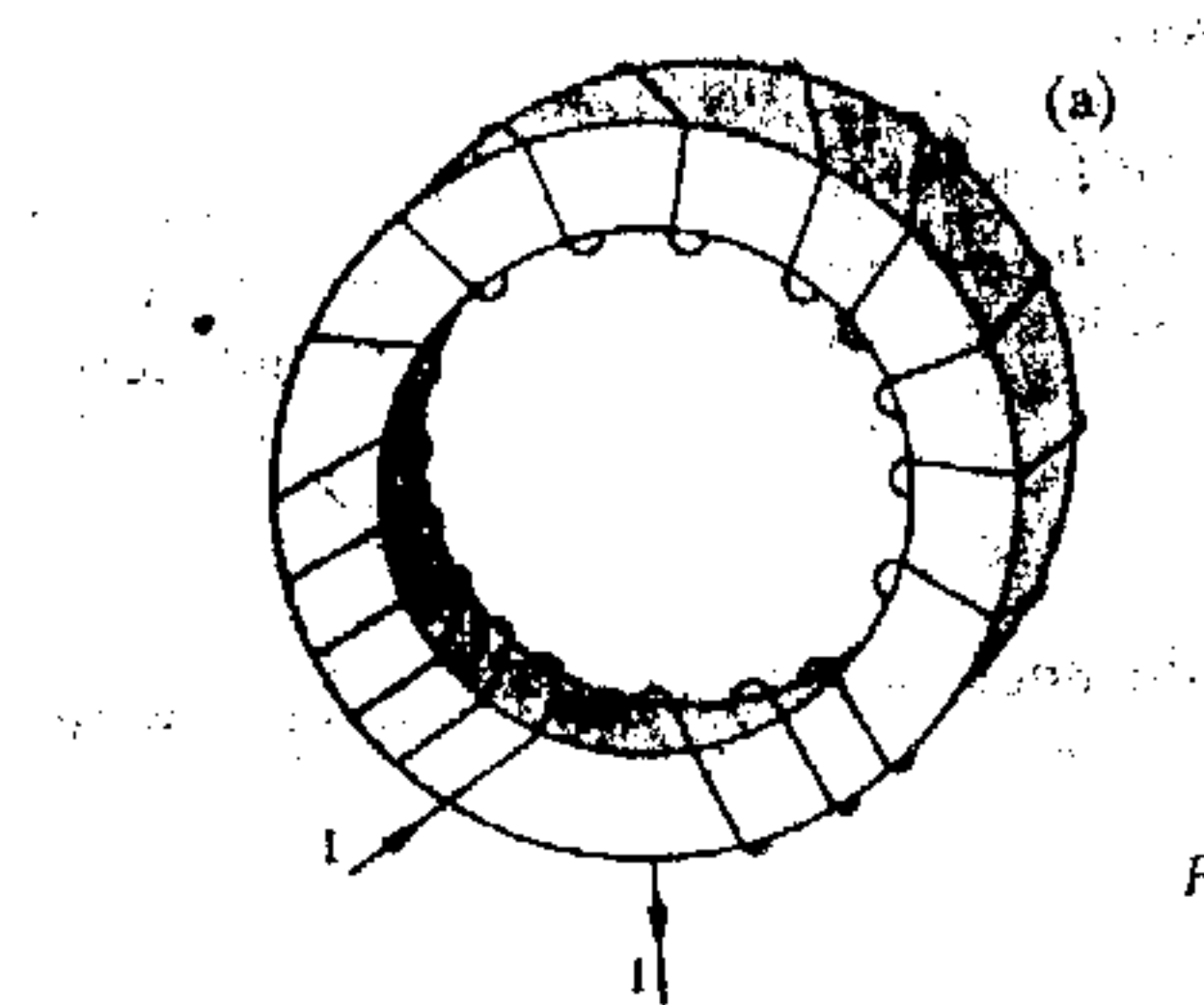
Or $\quad B = \mu_o I N$ or $= \mu_o N I$ ______(2)

Equation (2) gives the field due to long solenoid.

Application 2

Field due to Toroid:

"A long solenoid bent into ring shape is called Toroid."

Pictorially it is shown as given Figure:

When current I is allowed to pass through the Toroid the magnetic field is produced in the Toroid. The direction of this field is also determined by Right hand thumb rule. And the field in the middle of the Toroid is uniform and stronger where as the field outside and inside the Toroid is negligibly weak.

In order to calculate the field in the Toroid we take three paths as I, II and III as: shown in given figure

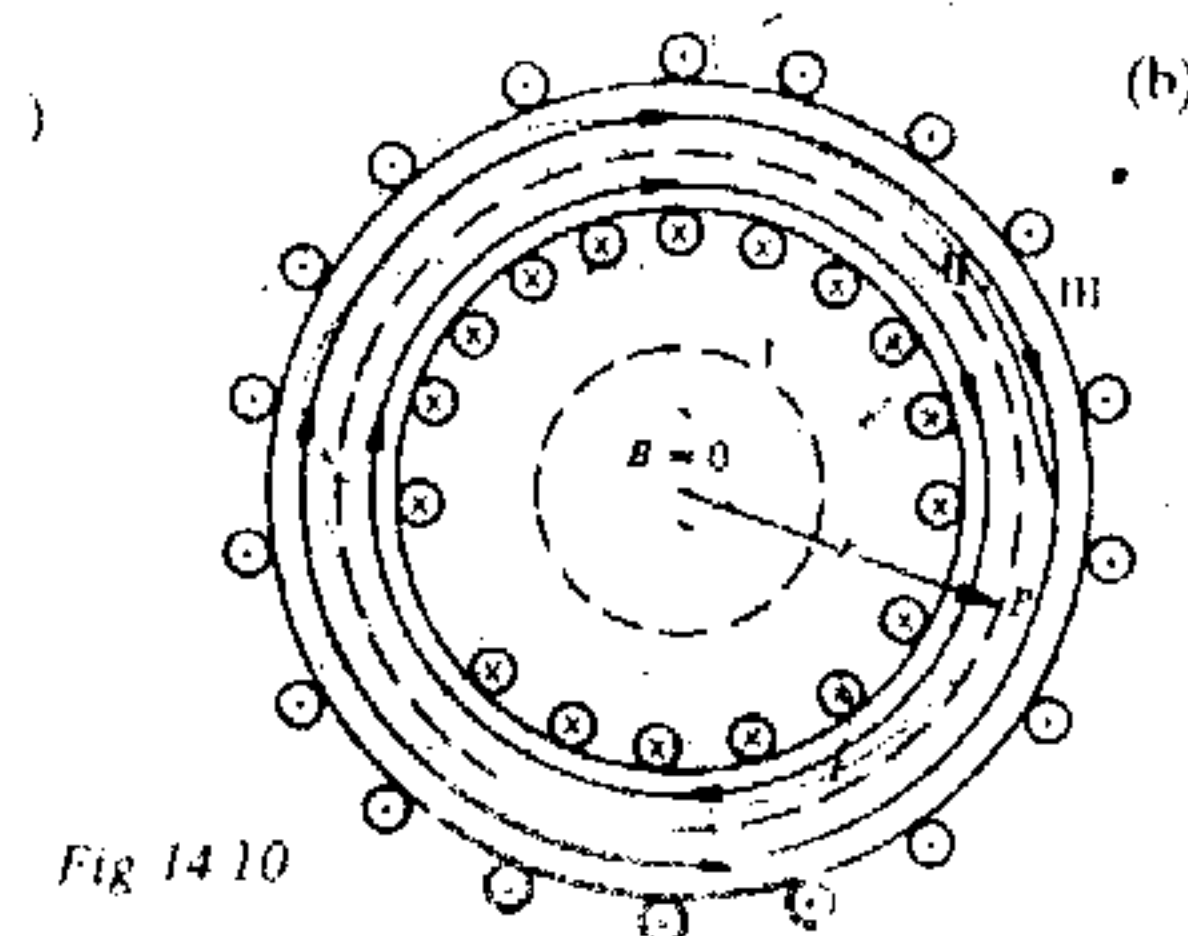



Fig 14 10

The path I and III lies inside and outside the Toroid. For path I if there is any field then:

$B \times$ Path I $= \mu_o I$

As no current is flowing through path I so I is zero hence $B \times$ Path I $= 0$

Similarly, for path III, $B \times$ Path III $= \mu_o I$ as $I = 0$ in path III so this product is also zero.

Now for path II, as the current I is flowing through this path, so $B \times$ Path II $= \mu_o I$ and path II is circular

Hence path II $= 2\pi r$ thus

$B_{\parallel} \times 2\pi r = \mu_o I$

Or $B \cos\theta \times 2\pi r = \mu_o I$

As "B" is Tagentional to the path so $\theta = 0$ the $B \cos 0 = B$. Then the Product is:

$B\, 2\pi r = \mu_o I$ ______________(1)

If there are N numbers of turns of the Toroid then we have;

$B \times 2\pi r = \mu_o N I$

Or $B = \mu_o NI / 2\pi r$ ______________(2)

Equation (2) gives the field due to Toroid.

METHODOLOGY

Instructions for Teacher:

1. Divide the topic in two periods
2. Mostly use black board
3. Demonstrate available experiments
4. Teach as the given activities

Activity No. 1:

Entering the class:

1. Ask some questions from the students as:
   i. What is electro magnetic?
   ii. What type of magnetic field is produced in electro magnet?
2. Knowing the answers of the question tell the students that in electro magnet the magnet field strength depend upon the current flowing through the conductor.
3. Write mathematically on the board as:

   $B \propto I$ & $B \propto 1/r$ of combining $B \propto I/r$ or $B = kI/r$ ______________ (1)

   'k' is constant of proportionality. Equation (1) is called Biot & Saverat Law.
4. Tell that Ampere's work on Biot & Saverat Law & replace 'k' by $\mu_o / 2\pi$, such that μ_o is the permibility of free space & '$2\pi r$' is the circumference of circular path, then equation is written as:

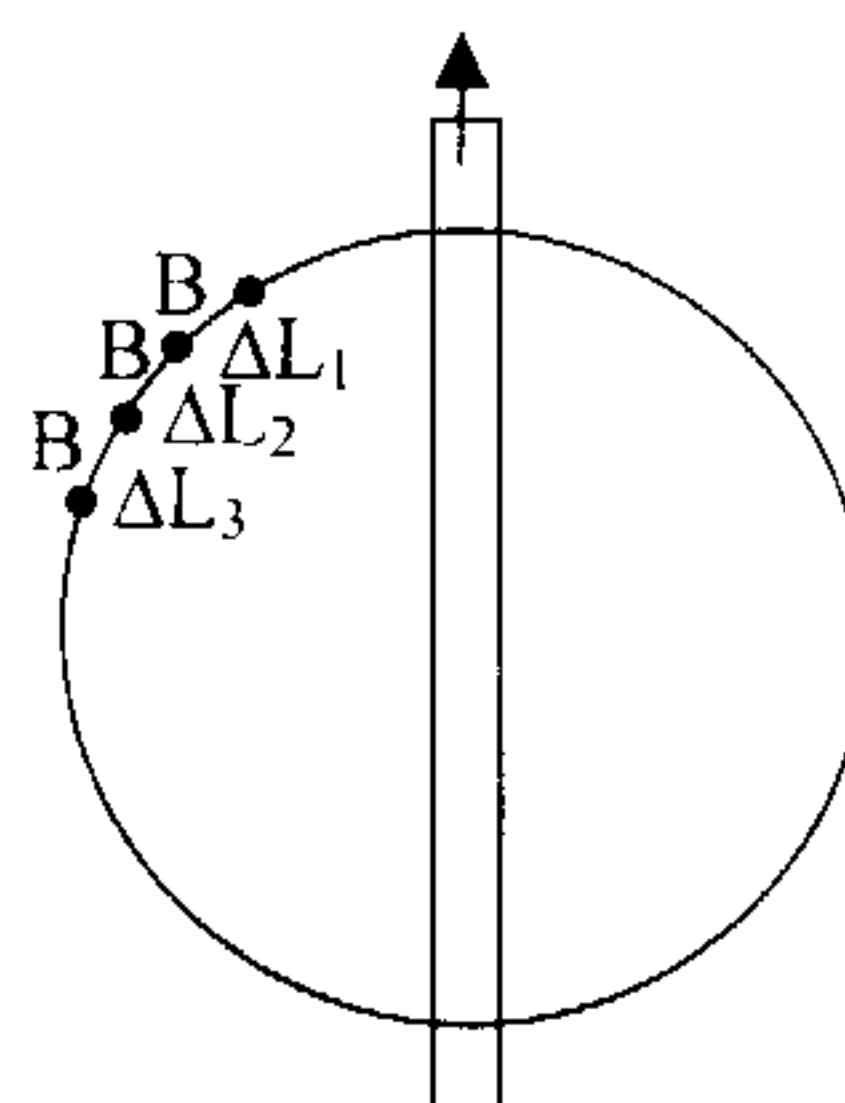
   $B = \mu_o I / 2\pi r$ ________________ (2)

Or $B \times 2\pi r / \mu_o I$

   If we replace $2\pi r$ = 'ΔL' the total length of the circular path then is:

   $B \times \Delta L = \mu_o$ ________________ (3)

   It is called Ampere's Law.
5. Write the statement of Ampere's Law on the black board.

6. Tell & explain by making the diagram of the conductor and then to find the product of B and length of the path in to small patches, so small that each patch become straight, unidirectional & parallel to the field lines as 'B'

becomes Tagentional and parallel and find mathematically, the product for each patch as:

$B_{||} \times \Delta L_1 = B \cos\theta \, \Delta L_1$

Where 'θ' is the angle between B & ΔL_1 and for parallel $\theta = 0$, then $\cos 0 = 1$, then $B \cos\theta \, \Delta L_1 = B \, \Delta L_1$

Similarly for 2[nd] patch it is $B\Delta L_2$, $B\Delta L_3$, ------------.

Now the total product is the sum of all these products on:

$B\Delta L_1 + B\Delta L_2 + B\Delta L_3 + B\Delta L_4 + B\Delta L_5 +$ -------------------

⇒ $B(\Delta L_1 + \Delta L_2 + \Delta L_3 + \Delta L_4 + \Delta L_5 +$ --------------------$)$

⇒ $B\sum_{i=1}^{n} \Delta L_i$

& This is equation to the product of μ_o & I, mathematically

⇒ $B\sum_{i=1}^{n} \Delta L_i = \mu_o I$

As $\sum \Delta L_i$ = Total length of circular path is

So $B \times 2\pi r = \mu_o I$ ________________ (4)

It is called Ampere's Law.

6. Ask some questions for involvement of the student as:
   i. How the product of B and length of the path is find out?
   ii. What is Ampere's Law?
   iii. What is Biot & Saverat Law?
7. Ask the students to write the topic on their notebooks.

Activity No. 2:

In this activity there is the use of Ampere's Law:

1. The teacher explains demonstrating that the Solenoid is a long tightly wounded insulating copper wire over the frame of non-magnetic material.
2. Draw the picture of the Solenoid on the board.
3. Explain on the black board the direction of current shown through the Solenoid with arrows.
4. Explain that the electromagnetic field at any point in the Solenoid is accordingly to right hand thumb rule and the direction of field in the middle of the Solenoid is stronger, uniform and unidirectional as in above figure. The field at the sides is opposite

to each other & cancel the effect of each other & the field in the middle portion is unidirectional & thus reion force each.

5. Tell & explain that, to calculate the field in the Solenoid put rectangular frame abcda as shown in above figure divide the frame in to four length segment as ab, bc, cd, & da. Find the product of B and length of each part is for bc, & da, the paths are perpendicular to the field lines. Thus it is equal to zero. For path cd, the length is out side the field so, it is also zero. Now for path ab, the product of B & length is:

$B \times l = \mu_o I$ ________ (1)

$\Rightarrow$ $Bl\ Cos\theta = \mu_o I$ as $\theta = 0$ then $Bl = \mu_o I$

If there are N numbers of turns of the coil per unit coil. Then for the length 'l' is Nl. Putting this:

$B \times l = \mu_o I\ Nl$

Or $B = \mu_o IN$ ________ (2)

Equation (2) gives the magnetic field due to Solenoid.

6. Ask the student to write on the notebook.

7. Explain the 2nd application of Ampere's Law, called field due to Toroid.

8. Explain with the demonstration as well as on the black board that the long Solenoid but in to ring shape is called Toriod as in the diagram. In Toriod when the current is passed the magnetic field is produced in the Toroid.

9. Explain on the black board that to find the product of B and the length of the path we take three path as I, II, & III respectively and explain that the path I & III lines outside & hence there is no field & for path II. The product is:

$B_{II}\ l = \mu_o I$

As $2\pi r$ is the length of closed path then $l = 2\pi r$

Then $B_{II} 2\pi r = \mu_o I$

As $\theta = 0$ then

$\Rightarrow$ $B\ 2\pi r = \mu_o I.$

If there are N numbers of turns then:

$\Rightarrow$ $B\ 2\pi r = \mu_o IN$

$\Rightarrow$ $B = \mu_o IN/2\pi r$ ______________ (3)

Gives the field due to Toroid.

10. Ask the student to write the topic on the notebooks.

Summary:

The summary of the topic is that, in this topic we study about the:

1. Electromagnetic field due to current carrying conductor.
2. Biot & Saverat Law is $B = kI/r$.
3. Ampere's Law, mathematically as $Bl = \mu_o I$
4. Method for finding the product of B & the length of the finding closed path by dividing the path into small length segment such that each segment is || to the B.
5. Application of Ampere's Law:

   i. The field due to Solenoid & ii. The field due to Toroid.
6. Solution of numerical problems relating to Ampere's Law.

Self Assessment:

(*Note:* Each question has 5 marks)

Q.No.1: What is electro magnetic field?

Q.No.2: What is the Biot & Saverat Law? Explain.

Q.No.3: What is Ampere's Law?

Q.No.4: How the product of B & the length of the path is find out?

Q.No.5: What is Solenoid? How the field due to it is find?

Q.No.6: What is Toroid?

Q.No.7: How the field due to Toroid is find out?

Q.No.8: Find magnetic induction at distance 0.1m of a straight wire through which 50A current is flowing?

Score Chart:

S.No.	1	2	3	4	5	6	7	8	Total
Marks									40

If the score is less than 40 then for guidance study for:

Q.No.1		Q.No.5	
Q.No.2		Q.No.6	
Q.No.3		Q.No.7	
Q.No.4		Q.No.8	

Lesson No. 5

Concept: ALTERNATING CURRENT GENERATOR

OBJECTIVES

Objectives of the Concept:

The objectives of the concept are to about:

1. The construction, working and function of A.C. generator
2. The flux, change of flux
3. The production of motional emf through the rotation of coil in a uniform magnetic field
4. The production of A.C. current
5. Mathematically calculation of equation of A.C. current
6. Application of A.C. voltage equation to solved the numerical problems

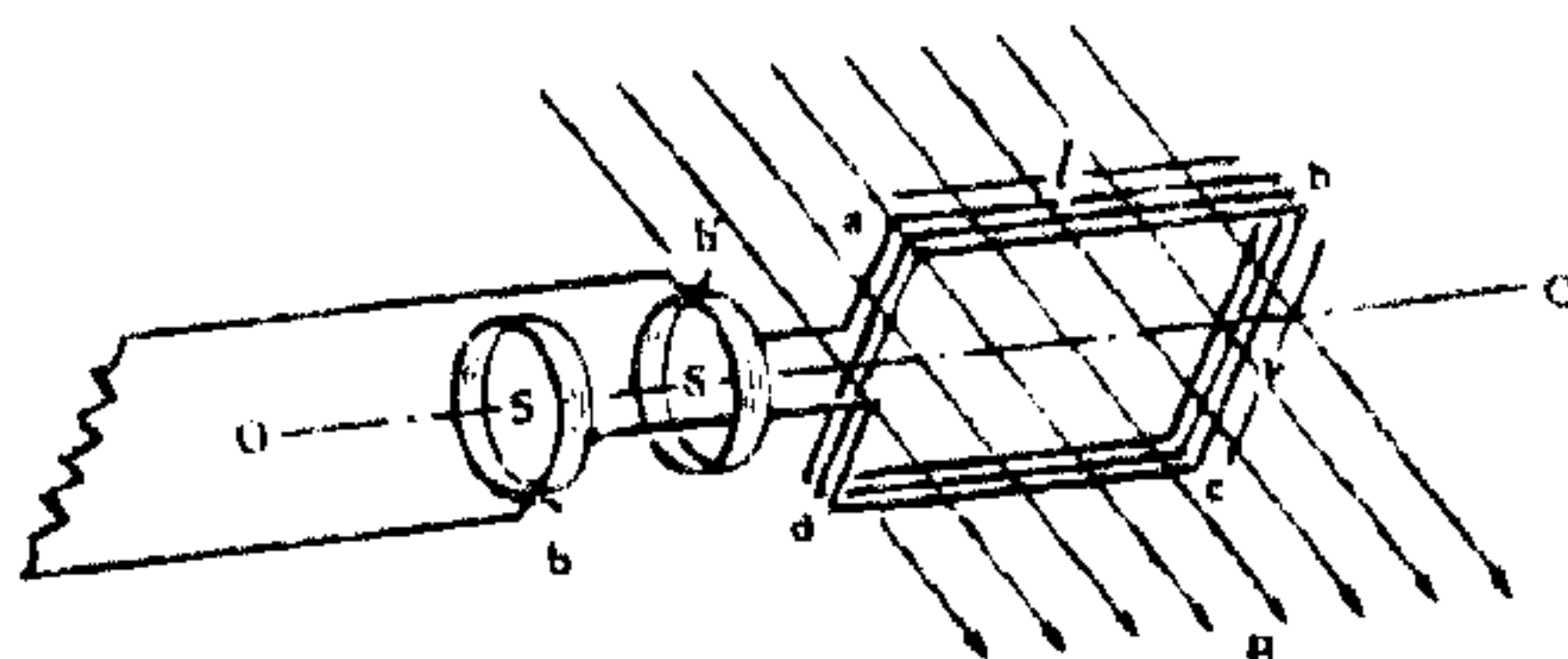
ALTERNATING CURRENT GENERATOR

Required Material:

Black board, Duster, Chalk, Generator, Chart of diagram of Generator, An Iron Rectangular Core, Enameled Copper Wire

Content: ALTERNATING CURRENT GENERATOR

"A generator is an electro mechanical device, which convert mechanical energy into electrical energy. It works on the principle of production of motional induced emf by changing the magnetic flux through the rotation of coil. When the produced induced emf is alternating and the current caused by it is called alternating current and the generator is called A.C. generator."

Pictorially it is shown in figure-I given below:

Principle of an ac generator

It consists of a rectangular coil abcda of N turns. which can rotate about an axis OO′ perpendicular to the direction of uniform magnetic field of flux density B. The ends of the coil are connected to two circular rings called slip rings S. S′ which rotates along the coil. Two Carbon brushes b. b′ connect the rings to external circuit. In commercial A.C. generator the magnetic field is provided by electro magnet & the coil is wounded on an iron core.

When the coil is made to rotate by some mechanical means in the filed. the flux of the coil changes and an induced emf is produced in the coil. In the beginning of the rotation. the plane of the coil is at right angle to the direction of magnetic filed and the induced emf is zero. When the coil is rotated clock wise the flux start decreasing and due to decrease in flux the induced emf goes on increasing and gets maximum value in the direction for question rotation. When the coil is further rotated to half rotation. the flux goes on increasing and emf goes and decreasing on half rotation the emf becomes zero but the direction is the same during the remaining half cycle the emf increases from zero to maximum and maximum to zero but in opposite direction. When the rotation is completed, emf is again zero.

The emf produced in one cyclic rotation is alternating and the current caused by it is also called alternating current.

For mathematical calculation of induced emf we take the length of the coil as 'l' width 'w' at any instant the plane of the coil is making an angle θ with the magnetic filed lines.

We know that the motional emf induced is:

$\varepsilon_i = BlV \sin\theta$ ______________ (1)

Where 'l' is the length of the conductor and θ is the angle between 'b' and 'l'. For the coil. the possible technique to calculate the emf of the coil is to divide the coil line the four length segments and then calculate the emf of each segment individually.

As the sides bc and da both moves in same direction and the emf produced by each side is $BlV \sin\theta$ and the net emf of these two sides is zero.

The emf of side ab = $BlV \sin\theta$ and side cd = $-BlV \sin\theta$

The net of these two sides is:

$\varepsilon_1 - \varepsilon_2 = BlV \sin\theta - (-BlV \sin\theta) = 2BlV \sin\theta$

The negative sign is used for opposite motion of side cd. The total emf induced is:

$\varepsilon = 2BlV \sin\theta$ ________________ (2)

Where 'l' is the length of the sides and 'V' is linear velocity of the coil. As the coil is rotating then: $V = r\omega$, where 'r' is the radius of the coil and $r = w/2$, then:

$V = \omega \times w/2$ (where ω is the angular velocity of the coil)

Putting the value of 'V' in equation (2), we have:

$\varepsilon = 2Bl \times \omega \times w/2 \sin\theta = Bl \times \omega \times w \sin\theta$

As $l \times w = A$ then $\varepsilon = BA\omega \sin\theta$

If the coil has 'N' number of turns then: $\varepsilon = BNA\omega \sin\theta$ __________ (3)

Where 'θ' is the angle between normal to the plane and field lines. When $\theta = 90$ the plane of the coil is parallel to the field and $\sin 90 = 1$ then: $\varepsilon = BNA\omega$ ________ (4), equation (4) gives maximum value of induced emf.

⇒ $\varepsilon_{max} = BNA\omega$ ________________ (5)

Putting equation (5) in equation (3), we have: $\varepsilon = \varepsilon_{max} \sin\theta$ __________ (6)

As $\theta = \omega t$, then: $\varepsilon = \varepsilon_{max} \sin\omega t$

When $\omega = 2\pi f$ then we have: $\varepsilon = \varepsilon_{max} \sin 2\pi ft$ ______________ (7)

If we replace $\varepsilon = V$ and $\varepsilon_{max} = V_o$, then $V = V_o \sin 2\pi ft$ _________ (8)

Here 'V' is the voltage at any instant and V_o is the maximum voltage.

"Here the voltage by the rotation of the coil varies sinusoidally and reverse its direction twice during the cycle, it is called alternating voltage and the current caused by this voltage is called alternating current. The generator that produce alternating current is called A.C. generator."

METHODOLOGY

Instructions for Teacher:

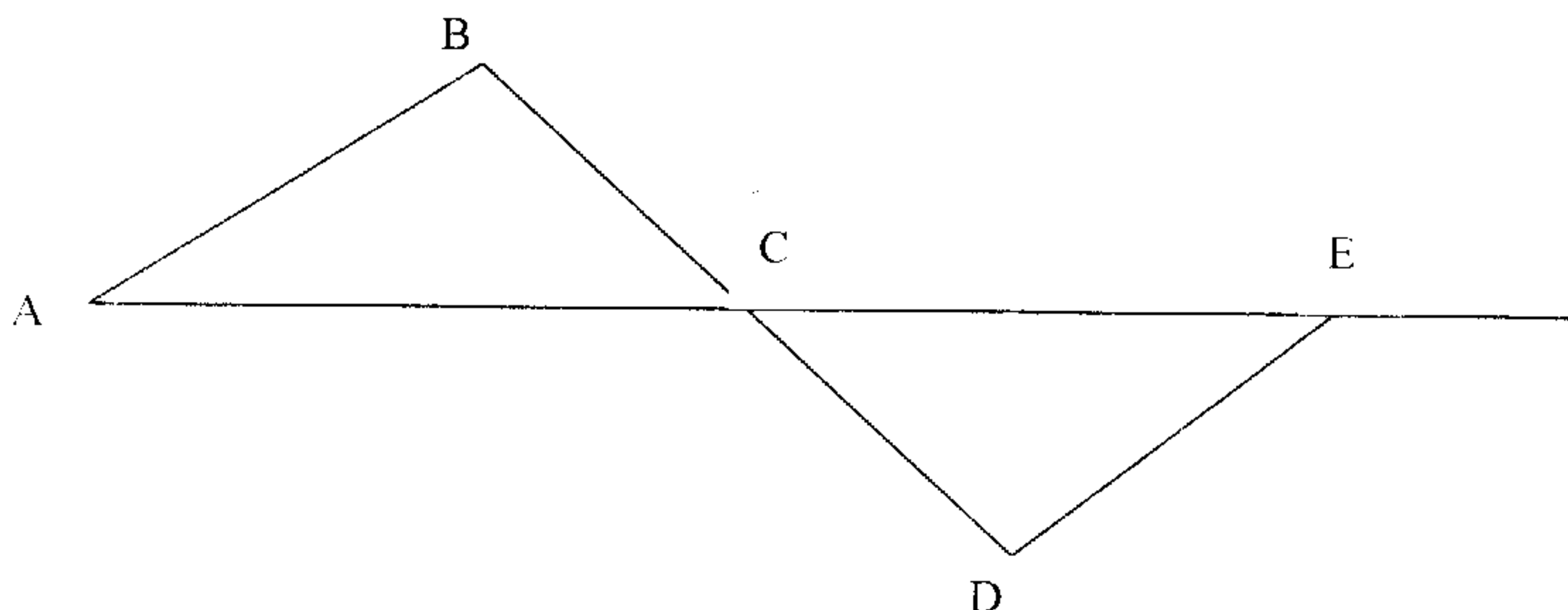
1. Divide the topic in two periods
2. Use mostly the black board
3. Demonstrate the available required material
4. Teach the concept as in the given activities

Activity No.1

On entering the class:

1. Ask some questions from the students about their previous knowledge as:
   - i. What is current?
   - ii. What is flux?
   - iii. What is induced emf?
2. Knowing the answer of the last question write the topic on the black board as:

ALTERNATING CURRENT GENERATE

3. Tell the students that generator is an electro-mechanical device, which convert Mechanical energy into Electrical energy.
4. It works on the principle of production of motional induced emf by changing the magnetic flux through the rotation of coil. When the produced emf is alternating then the current caused by it is called alternating and the generator is called A.C. generator.
5. Draw the diagram of A.C generator on the black board.
6. Demonstrate the students with the help of a book, that the plane of the coil is perpendicular to the direction of magnetic field line and the field lines are passing through the coil and the coil can rotate around the axis OO′ perpendicularly to the magnetic field lines.
7. Demonstrate the rotation of coil as clockwise.
8. Tell that in the beginning of the rotation the plane of the coil is at right angle to the direction of field lines and induced emf is zero. On rotation, the flux start decreasing and the induced emf goes on increasing and get maximum value in positive direction for quarter rotation. After quarter rotation the plane becomes parallel to the field lines and on further rotation the flux increases and the induced emf decreases, till the rotation is half.
9. Draw the graph of the half rotation on the blackboard as:

10. Tell that for remaining half cycle the induced emf goes from zero the maximum and maximum to zero but in negative direction as in above graph.
11. When the rotation is completed, the emf is again zero.
12. Tell the students that the produced emf during one cyclic rotation is alternating, thus the current caused by it is also alternating and the generator is called A.C. generator.
13. Ask some question from the students for their involvement as:
    i. How the coil is made?
    ii. How the flux change?
    iii. Why the emf produced is alternating?
    iv. Ask the students to write the topic on their notebooks.

<u>Activity No.2</u>

In this activity:

1. Tell the students the mathematical calculation of induced emf by writing on the black board .
2. Tell the students that for mathematical calculation of emf, divide the coil in four length segments as ab bc, cd and da; such that the sides bc and da both moves in some direction and the emf produced by each side is BIV Sinθ. Their net emf is zero. And the sides ab and cd move in such a way that when ab moves downward, cd moves upward and similarly, the emf produced by these sides is as BIV Sinθ and -BIV Sinθ, the negative sign is for opposite rotation. The net of these two sides is:

$\Rightarrow$ BIV Sinθ - (-BIV Sinθ) $\Rightarrow$ 2BIV Sinθ

3. Tell the students that in above equation V is the linear velocity of the coil.
4. Explain the topic on the blackboard.
5. Ask the students to write the topic on their notebooks.

6. Solve numerical problems of A.C. generator on blackboard with the help of students.

Summary:

The summary of the topic is:

1. The construction and working of A.C. generator
2. The production of alternating voltage and alternating current
3. The phenomenon of change of flux induced emf and induced current.
4. Mathematical equation of A.C. voltage.
5. Application of generator and application of mathematical equation to solve the numerical problems.

Self Assessment:

(*Note:* Each question has 5 marks)

Q.No.1: What is an alternating current generator?

Q.No.2. Explain the rotation of coil in magnetic field?

Q.No.3. When the induced emf is positive and when negative?

Q.No.4. What is the perpendicular distance of rotation for induced emf?

Q.No.5. Write the mathematical question for motional induced emf?

Q.No.6. When the maximum voltage is produced write its equation?

Q.No.7. Draw the diagram of A.C. generator?

Q.No.8. Prove the equation for alternating voltage produced in A.C. generator?

Score Chart:

Q.No	1	2	3	4	5	6	7	8	TOTAL
MARKS									X/40

Lesson No. 6

Concept: MODERN PHYSICS

OBJECTIVES

Objectives of the Concept:

1. To know about the modern physics
2. To know about the new concepts of modern physics
3. To know the relative motion
4. To know the difference between accelerated and non accelerated frame of references.
5. Use & application of new concept of physics in new fields of science.

Concept: MODERN PHYSICS

Required Material:

Chalk, Duster, Black Board.

Content:

Modern Physics:

> *"The word physics means the science of matter in which the behavior, characteristics and properties of matter are explained. Physics is an old branch of science, which deals with the some fundamental laws, principles and ideas on the basis of natural phenomena's."*

At the end of 19^{th} century the physicist believed that the science of physics had been completed, but in the beginning of 20^{th} century some famous scientist such as Einstein, Morley, Bohr, De-Broglie, Michelson, Schrodinger and others presented a series of some new ideas, laws, concepts and experiments which challenges all the older ideas, concepts laws & experiments. These new ideas, laws concepts and experiments were chiefly concerned with the bodies extremely small that are moving with velocities extremely large. The science of these new ideas, concept, laws of principles that was explained on the basis of new ideas, concept, laws & principles that was explained on the basis one and more fundamental & general results was given the name of modern physics.

In which we study about microscopic and sub micro scopic particles. It is the branch of physics in which we study about the behavior, characteristic & properties of an atom and sub atomic particles like proton and electron. In this branch we also study about "Relative Motion and Quantum Mechanics". In simple words:

"It is the physics of more general concepts, ideas and laws."

The new concepts and laws of modern physics are as:

i. There is no thing as Ether

ii. Velocity of light is universal constant

iii. All the motions are relative. Nothing is absolute rest and absolute motion.

iv. The laws of physics may be explained in the same set of equation for all the frame of reference moving with constant velocity w.r.t one another.

v. Energy and men are not entirely distinct quantities energy can be converted into man o& mass can be converted into energy.

vi. The waves & particles are not two distinct concepts. The waves have particles properties and the particles have wave properties.

vii. Action cannot be measured with accuracy better then "h".

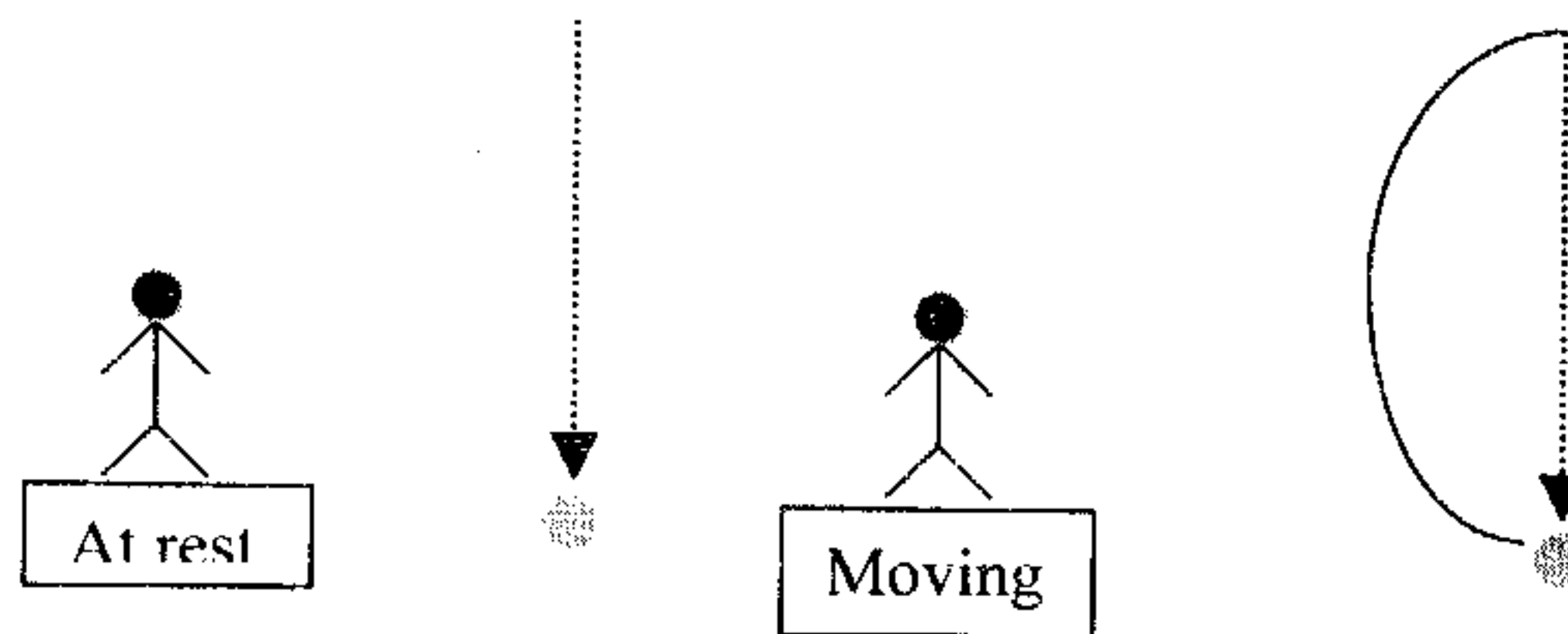
viii. The energy of a beam of light having frequency v is:

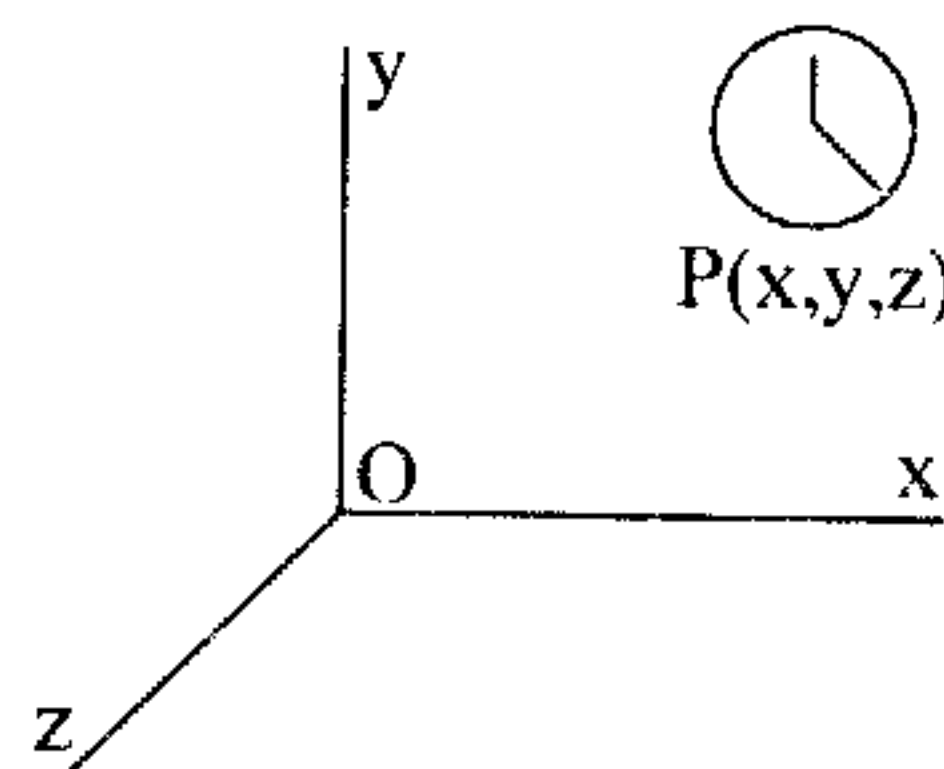
$E= hv$, (where h is plank's constant)

Relative Motion:

In the beginning of 20th century, a famous scientist Einstein presented a new idea about space and time. To him: 'The space and time are relative they have different values for different observers at different places.' According to him: 'One cannot say that an object is in an absolute motion or at absolute rest but one can say that the body is in motion w.r.t another and at rest w.r.t another body. The motion of a body w.r.t another body is called relative motion.'

Einstein explain the concept of relative motion by very simple examples, he said that the walls of a moving train are at rest w.r.t a person sitting in a train and the same walls of the train are in motion for a person sitting out side the train.

Similarly, a free falling stone, is when observed by a man at rest, he observed straightly coming down ward and when observed by a man moving, he will observed that the stone is coming down word on a curved path. Pictorially shown as:

Frame of Reference:

As it has been known that nothing is at rest, all the motions are relative. For this it was assumed a point known as arbitrary origin with respect to which the location of a body is determined. This particular point is called arbitrary origin or reference origin or reference axis. This reference axis is also called 'Frame of reference'. In space, the frame of reference consists of three mutually perpendicular axis fixed on the earth along with a clock. The position of an object is determined by a set of three co-ordinate axis namely as x-axis y-axis and z-axis respectively as shown given figure:

Frame of reference are of two kinds:

1. Inertial frame of reference
2. Non-inertial frame of reference

1. Inertial frame of reference:

A frame of reference that is moving with uniform velocity with respect to another frame of reference or it is at rest is called inertial frame of reference. In simple wording it is also called non-accelerated frame of reference.

A frame of reference fixed on the surface of earth is very nearly an inertial frame of reference. To explain the Phenomenon with simples examples we give the example of the position of a school from the home, where the home is reference axis. Similarly, we can give so may other examples.

2. **Non-inertial frame of reference;**

A frame of reference that is moving with certain acceleration w.r.t other frame of reference is called non-inertial frame of reference example of this frame is the person sitting in the train is asked to determine to distance of school w.r.t the train / van / bus / cycle. The person sitting in an elevator / lift.

These frames are also known as accelerated and non-accelerated frames respectively. We can explain the concept of accelerated & non-inertial frame of reference by various examples of daily life.

METHODOLOGY

Instructions for Teacher:

1. This lesson is for one person.
2. Use the black board.
3. Give simple examples to explain the concept of relative motion & frame of reference.

Activity:

On entering the class:

1. Ask some question from the students as:
   - i. What is Physics?
   - ii. What are the branches of Physics?
   - iii. What is modern Physics?
2. Knowing the short answer of last question, tell the students about the Physics, that:

   > *"It is the branch of science in which we study about the Physical nature of the universe, about the matter, characteristics of the matter, properties and behaviors of the matter. It is the branch of science which deal with the fundamental laws, principles and ideas of natural phenomenon."*

3. Tell the students that modern Physics is a Physics of 20^{th} century. It is also Physics of more general concepts and ideas that are concerned with the bodies extremely small moving with very large velocity. It is the physics in which we study about microscopic and sub-microscopic particles particularly we study about the elementary particles of the atom.
4. Tell the students about the new & more general concepts of modern Physics.
5. Tell the students that the relative motion is the motion of one body with respect is another body.
6. Explain it giving the examples of localization.
7. Explain & demonstrate the concept of frame of references with the help of blackboard.
8. Explain with example the internal and non-internal frame of reference.

9. Ask the students to write the topic on their notebooks.
10. Ask some questions from the students as:
    i. What is modern Physics?
    ii. What is relative motion?
    iii. Give an example of internal frame of reference.
    iv. What is the velocity of light?

Summary:

In this topic we study about the:

1. Modern Physics
2. Difference between classical Physics & modern Physics
3. New concepts of modern physics
4. The relative motion
5. Frame of references
6. Inertial frame of reference and non inertial frame of reference.

Self-Assessment:

(*Note:* Each question has 5 marks)

Q.No.1 Name of scientists of 20^{th} century.

Q.No.2 Define modern physics.

Q.No.3 What is relative motion? Give an example.

Q.No.4 Define accelerated frame of reference.

Q.No.5 What are new concepts of modern Physics?

Q.No.6 Give an example of non-accelerated frame of reference.

Score Chart

S.No	1	2	3	4	5	6	Total
Marks							30

If the score is less than 30 then Re-study for guidance as

Q.No.1		Q.No.4	
Q.No.2		Q.No.5	
Q.No.3		Q.No.6	

Lesson No. 7

Concept: ATOMIC SPECTRA

OBJECTIVES

Objectives of the Concept:

1. How the elements are made in gaseous state
2. What is spectrum? How it is obtained & what are the fundamental characteristics of spectrum?
3. To know the different between the light of visible region, ultraviolet & infra red regions.
4. To know the use of discharge tube.
5. To know the excitation & de-excitation of the atoms

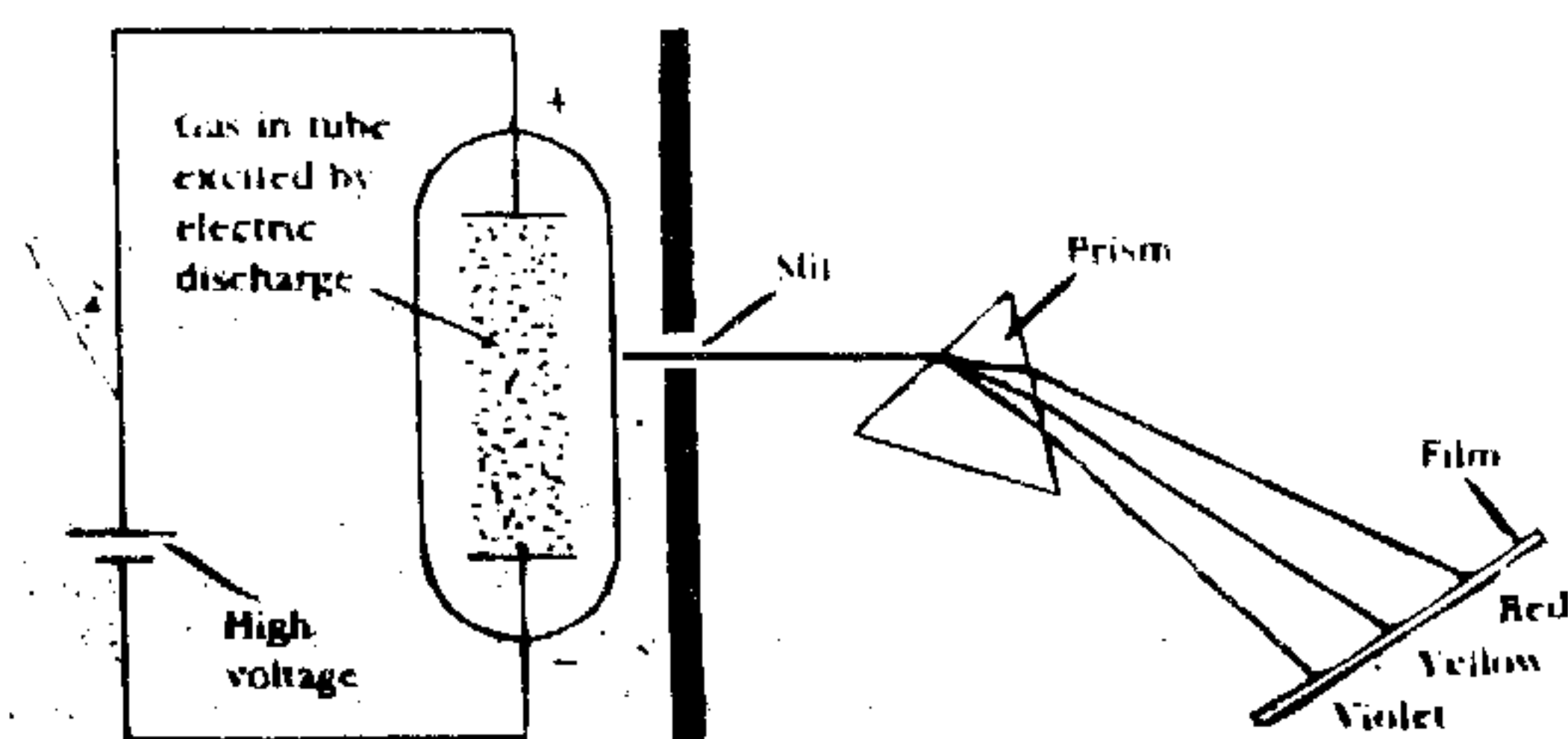
Concept: ATOMIC SPECTRA

Required Material:

Chart of Periodic Table, Blackboard, Chalk, Duster, Chart of Diagrams of Discharge Tube and Spectrum

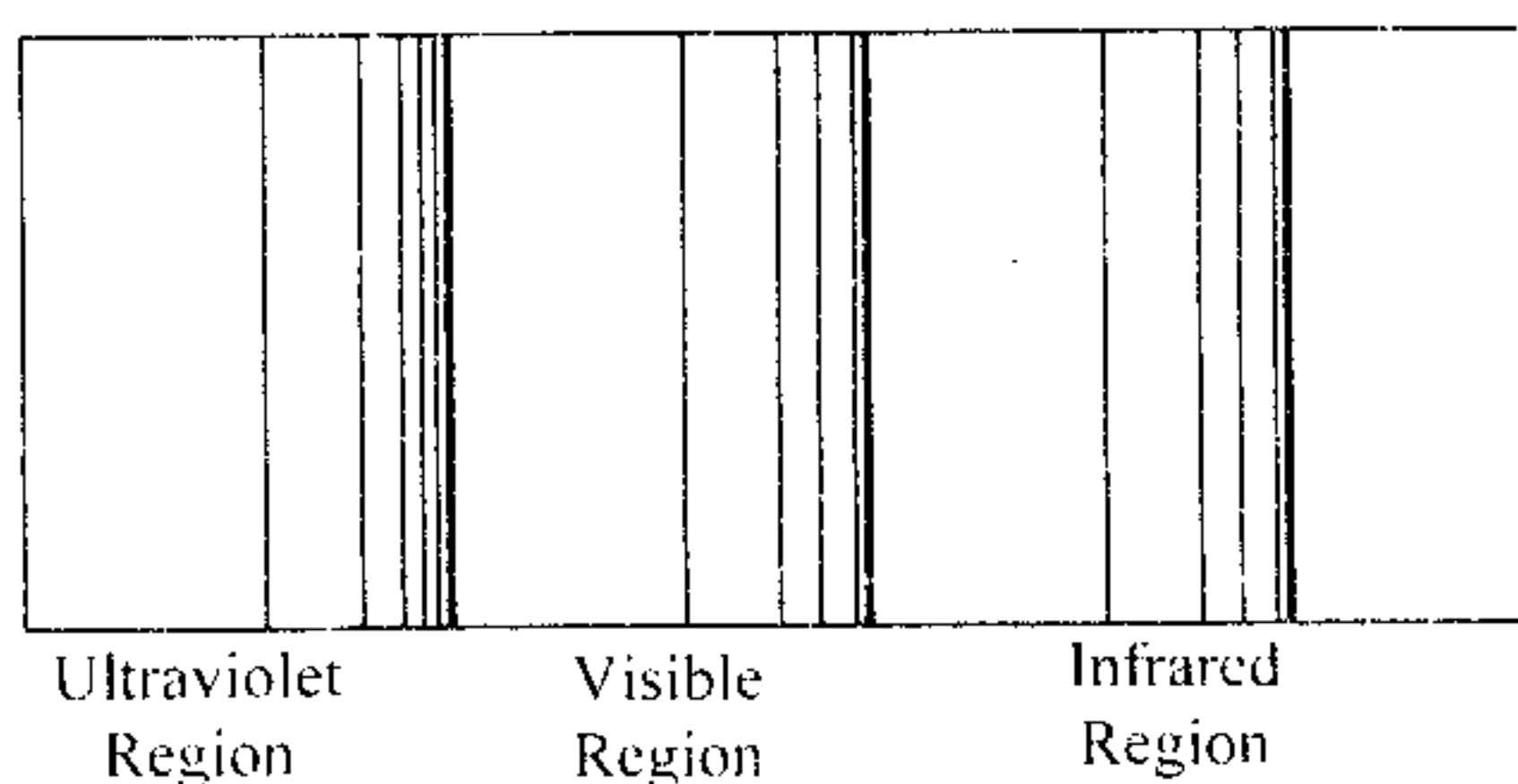
Content:

During the last years of the 19th century, it was discovered by the scientists that almost all the elements emit light, which consist of set of particular frequencies, under certain condition.

- The experiment arrangement of getting light from the atoms of an element consist of a polished discharge tube with a small circular portion of the tube un polished through which the light can leave the tube as shown in given Figure:

A schematic representation of the experimental arrangement for observing spectra of different atoms.

An element in gaseous state is filled in the discharge tube for elements other than gases are made in gaseous state by vaporizing them. It is done due to the reason that in gaseous state the atoms of an element do not influence other. The discharge tube is connected to a high voltage source and an electrical current is passed through the tube. Due to electrical discharge. the atoms of an element become excited. i.e. they jump to their higher orbits. When maximum number of atoms becomes excited, then the voltage source is removed & the excited atoms return back to their ground state by emitting energy or light in the form of radiation. These radiations when leave the tube through un polished portion of the tube and made to pass through the dispersing device such as prism and then fall on the screen. On he screen these radiations are splitted into different layers of definite colors based upon the nature of that element. These different layers of definite colors on the screen is called spectrum as this spectrum is obtained due to light omitted by the atoms of an element therefore it is called spectrum of an atom or Atomic spectra.

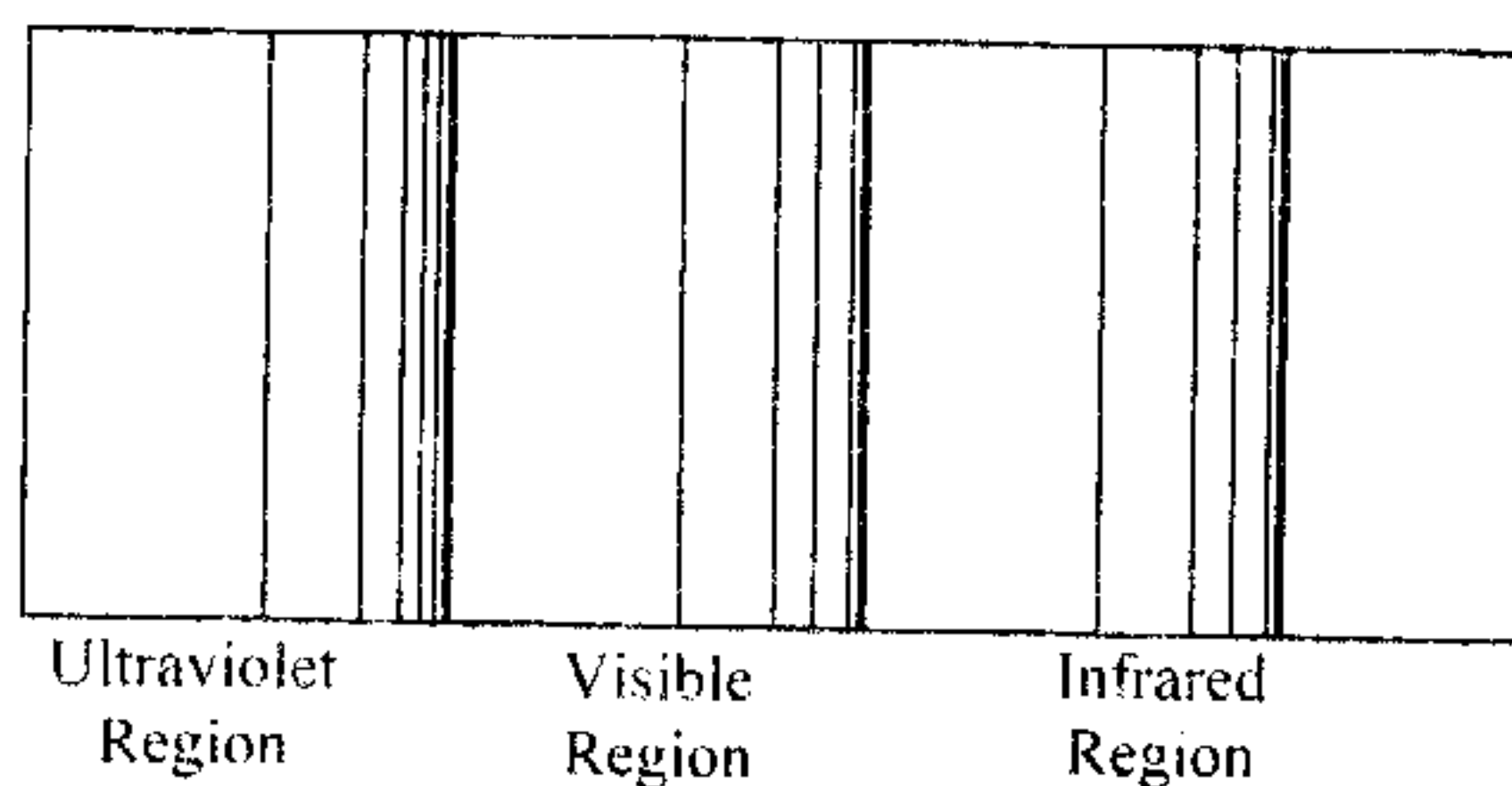
The detail study of atomic spectra gives the following characteristics of spectrum:

1. The spectrum of no two elements are alike.
2. The spectrum of each element consists of number of series, which are spread not only over the visible region but also on the infrared and ultra violent region.
3. All the series of spectrum either of same element or of different elements are similar in general appearance.
4. The lines of the series are called spectrum lines and these lines of each series are well separated at one side of the series and this separation rapidly decreases towards the other side of the series. The line at the end of the series is called series limit. The lines up to the series limit are called discrete lines and the spectrum up to the discrete line is called Line Spectrum and the spectrum after this line is called continuous spectrum.
5. The spectrum of an element is pictorially shown as in given figure:

Spectrum of Hydrogen Atom:

Hydrogen is the smallest element amongst all the elements. It consists of only one electron in the 1st on orbit and only one portion in the nucleus. Further more it is in gaseous state and has small size and small mass.

When Hydrogen gas is filled in the discharge tube and the atoms of it are excited by mean of High Voltage source, and on removing the voltage source, the excited atoms return back to their ground state, they emit light in the form of radiation. This light after leaving the Tube is made to pass through the prism and then fall on the screen.

Then we see the different layers of definite colors on the screen. These different layers of definite colors seen on the screen is called spectrum as this spectrum is obtained due to the light emitted through the hydrogen atoms, so it is called Hydrogen Spectrum.

This spectrum is pictorially shown as in given figure:

The spectrum of H-atom consists of number of series that are spread not only over the visible region but also on the ultraviolet and infrared region. The series that lies in the visible region was 1st time studied by a famous scientist "Balmer" who give an empirical formula for finding the wave length and frequency of each spectrum line in visible region. This series is therefore also called Balmer series. The formula for wavelength is given as:

$$1/\lambda_n = R(1/2^2 - 1/n^2) \quad \text{—————— (1)}$$

Where n is an integer, having the values n = 3,4,5,6............. and λ_n is the wave length on nth line, R is constant called Red Bergs' constant and its value is:

$R = 1.0974 \times 10^7\ m^{-1}$

For 1st line n = 3 and so on.

As the n increases the lines comes closer to each other. And for $n = \infty$, the line is last line, called series limit. It is numerically given as:

$1/\lambda_n = R(1/2^2 - 1/\infty^2) = R(1/4 - 0) = R/4 = 1.0974 \times 10^7\ m^{-1} \times 1/4$

Or $\lambda_n = 3.6449 \times 10^{-7}\ m$

The series of H-atom that lies in the ultraviolet region was studied by Layman, who also find the formula for finding the wavelength and frequency of each line. This series is also called Layman Series. His formula is:

$1/\lambda_n = R(1/1^2 - 1/n^2)$ ______________________ (2)

Where n is an integer having values 2,3,4,5,-------------------. For 1st line n = 2 and so on.

Similarly, the series that lies in infrared region was studied by Paschen, & known as Paschen series. The formula of this series is:

$1/\lambda_n = R(1/3^2 - 1/n^2)$ ______________________ (3)

Where n = 4,5,6,--------------------. For 1st line n = 4 and so on.

In infrared region two other series was also found known as 'Bracket and Pfund' series. There formulae are:

$1/\lambda_n = R(1/4^2 - 1/n^2)$ ______________________ (4)

$1/\lambda_n = R(1/5^2 - 1/n^2)$ ______________________ (5), respectively.

The general formula for combined series is:

$1/\lambda_n = R(1/p^2 - 1/n^2)$ ______________________ (6)

Where p = 1,2,3,4,5,--------------------, and n = p+1, p+2, p+3, ---------------------.

METHODOLOGY

Instructions for Teacher:

1 Divide the concept in two periods.

2. Mostly use Black Board.

3. Demonstrate the available equipments to the students.

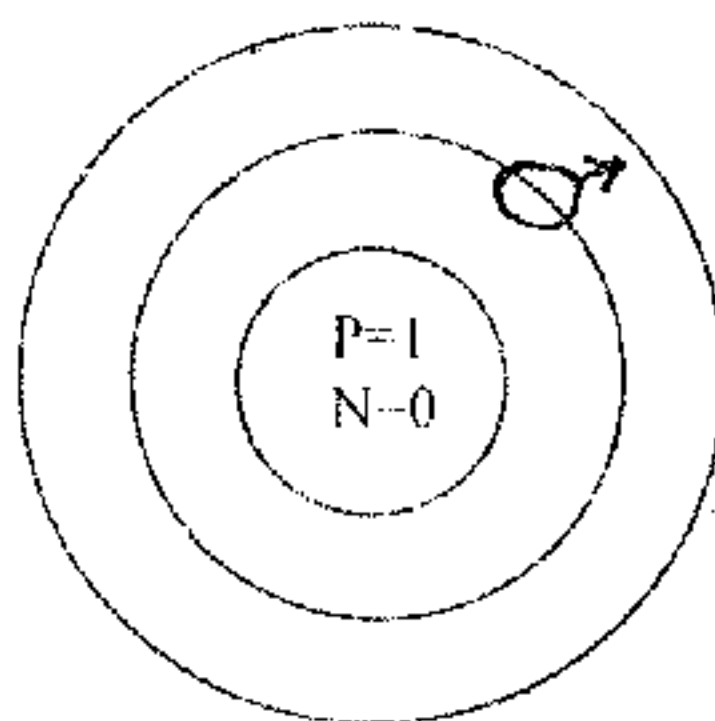
4. Teach the concept by the following activities.

Activity No: 1

On entering the class:

1. Fix a chart of periodic table on the one side of the Black Board.
2. Tell the students about the elements in the periodic table.
3. Write the topic on the Black Board.
4. Tell the students the following:

During the last years of 19th century, it was discovered by the scientists that almost all the elements emit light, which consist of set up particular frequencies under certain condition. When any one of these element is filled in the discharge tube in gaseous state and then electrical current is passed through the tube by connected it with a high voltage source, the atom of element will be excited i.e. it will jump to higher orbits.

5. To explain; Draw the diagram of H. atom as given:

6. The electron in the 1st orbit is in normal state and when it will jump to orbit 2 is called excited state.

7. Tell the students that when the voltage source is removing the excited electron will jump down and emit light in the form of radiation. When these radiation of light are made to leave the tube through un polished portion of the tube and then after passing through the prism when fall on the screen, we see the different layers of specified colors

of that element. These different layers of definite colors on the screen are called spectrum of an atom or Atomic spectra.

8. Ask the following question:

   i. How the atoms of elements emit light?

   ii. How the atom excited?

   iii. When the atoms are excited?

   iv. Discuss these questions on the blackboard.

Activity No. 2:

1. Tell the students that Hydrogen is the 1st element in the periodic table. It has only one electron in the 1st orbit and one proton in the nucleus. It is in gaseous state. When it is filled in the Tube and after passing the electrical current, the atoms will be excited and on de-excitation the light will be emitted be emitted. This light when will pass on the screen after passing through the prism, different layers of definite colors will be seen in the screen.

2. These different layers of definite colors on the screen is called the spectrum of H-atom.

3. Draw the diagram of spectrum on the blackboard showing that this spectrum is spread not only over the visible region but also on the ultra violent and in infrared region.

4. Tell the student that the lines of spectrum as well separated at one side and this separation rapidly decreases toward the other side. The last line is called discrete line and the spectrum up to the last line is called line spectrum and the spectrum after the last line is called continuous spectrum.

5. Tell the students that the series that lies in the visible region was studied by Balmer who find an empirical formula to find the wavelength and frequency of these lines. This series is therefore Balmer series. Similarly the series of ultraviolet region is called Layman series and the infrared region series is called Paschen series.

6. Ask the following questions:

   i. How the spectrum H-atom is obtained?

   ii. How the atoms are excited?

   iii. Define Balmar, Layman and Pashen series.

Summary:

The summary of the topic is:

1. Atomic Spectra
2. Hydrogen Spectrum
3. Series of Spectrum
4. Formula for finding the wavelength and frequency of Spectral lines.

Self-Assessment:

(*Note:* Each question has 5 marks)

Q.No.1 Why an element is filled in discharge tube in gaseous state?

Q.No.2 How the atoms of an element are excited?

Q.No.3 Define line spectrum and continuous spectrum?

Q.No.4 Find the wavelength of second line in Layman series?

Q.No.5 Explain visible light, ultraviolet light and infrared light?

Q.No.6 Find the wavelength of shortest line in Balmer series?

Q.No.7. Write the general form of empirical formula for finding wavelength?

Q.No.8. Write the characteristics of atomic spectra?

Score Chart:

Q.No.	1	2	3	4	5	6	7	8	Total
Marks									40

If the score is less than 40, then re-study is as given below:

Q.No.1		Q.No.5	
Q.No.2		Q.No.6	
Q.No.3		Q.No.7	
Q.No.4		Q.No.8	